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Emissions
Test Report

EUT Name: Bluetooth Module for JADAK/PRI Equipment

Model No.: JADAK/PRI P/N 6XYZ-0003-01

CFR 47 Part 15.247:2017 and RSS-247:2017

Prepared for:

JADAK (a wholly owned subsidiary of Novanta Corporation)
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Revisions

Revision No.	Date MM/DD/YYYY	Reason for Change	Author
0	05/22/2017	Original Document	N/A
1	12/01/2017	Update Test Result with Host Device	J. Luong

Note: Latest revision report will replace all previous reports.

Statement of Compliance

Manufacturer:	JADAK 7279 William Barry Blvd. North Syracuse, New York, 13212 USA
Requester / Applicant:	Steven Bryant
Name of Equipment:	Bluetooth Module for JADAK/PRI Equipment
Model No.	JADAK/PRI P/N 6XYZ-0003-01
Type of Equipment:	Intentional Radiator
Application of Regulations:	CFR 47 Part 15.247:2017 and RSS-247:2017
Test Dates:	13 May 2017 to 20 November 2017

Guidance Documents:

Emissions: ANSI C63.10-2013

Test Methods:

Emissions: ANSI C63.10-2013

The electromagnetic compatibility test and documented data described in this report has been performed and recorded by TUV Rheinland, in accordance with the standards and procedures listed herein. As the responsible authorized agent of the EMC laboratory, I hereby declare that the equipment described above has been shown to be compliant with the EMC requirements of the stated regulations and standards based on these results. If any special accessories and/or modifications were required for compliance, they are listed in the Executive Summary of this report.

This report must not be used to claim product endorsement by A2LA or any agency of the U.S. Government. This report contains data that are not covered by A2LA accreditation. This report shall not be reproduced except in full, without the written authorization of TUV Rheinland of North America.

Richard Decker	December 1, 2017	David Spencer	December 1, 2017
Test Engineer	Date	Laboratory Signature	Date

Testing Cert #3331.02 **US1131** **2932M-1**

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The Friss transmission formula: Pd = (Pout*G) / (4*π*R^2) 72

Ref. : David K. Cheng, Field and Wave Electromagnetics, Second Edition, Page 640, Eq. (11-133). 72

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1 Executive Summary

1.1 Scope

This report is intended to document the status of conformance with the requirements of the CFR 47 Part 15.247:2017 and RSS-247:2017 based on the results of testing performed on 13 May 2017 to 20 November 2017 on the Bluetooth Module for JADAK/PRI Equipment Model JADAK/PRI P/N 6XYZ-0003-01 manufactured by JADAK This report only applies to the specific samples tested under the stated test conditions. It is the responsibility of the manufacturer to assure that additional production units of this model are manufactured with identical or EMI equivalent electrical and mechanical components. This report is further intended to document changes and modifications to the EUT throughout its life cycle. All documentation will be included as a supplement.

1.2 Purpose

Testing was performed to evaluate the EMC performance of the EUT in accordance with the applicable requirements, procedures, and criteria defined in the application of regulations and application of standards listed in this report.

The report documents the 2.4GHz radio characteristics for the JADAK/PRI P/N 6XYZ-0003-01 Bluetooth Module.

1.3 Summary of Test Results

Table 1: Summary of Test Results

Test	Test Method ANSI C63.4:2014/ ANSI C63.10:2013	Test Parameters	Measured Value	Result
2402 MHz to 2480 MHz Band				
Spurious Emission in Transmitted Mode	CFR47 15.209, RSS-Gen Sect.8.9	Class B	-1.40 dB (Margin)	**Complied**
Restricted Bands of Operation	CFR47 15.205, RSS-Gen Sect.8.10	Class B		**Complied**
AC Power Conducted Emission	CFR47 15.207, RSS-GenSect.8.8	Class B	-4.70 dB (Margin)	**N/A**
Occupied Bandwidth	CFR 47 15.247(a1), RSS Gen Sect. 6.6 & RSS 247 Sect.5.1(a)	N/A	20dB BW = 1027 kHz 99% BW = 970 kHz	**Complied**
Channel Separation	CFR47 15.247 (a1), RSS 247 Sect. 5.1(b)	>25 kHz	990.3 kHz	**Complied**
Number of Hopping Channels	CFR47 15.247 (a1), RSS 247 Sect. 5.1(d)	>15	79 Channels	**Complied**
Average time occupancy of Channel	CFR47 15.247 (a1), RSS 247 Sect. 5.1(d)	< 0.4 sec	316.66 mS	**Complied**
Maximum Transmitted Power	CFR47 15.247 (b1), RSS 247 Sect. 5.4(b)	< 1.0 Watt	2.97 mW (4.73dBm)	**Complied**
Out of Band Emission	CFR47 15.247 (d), RSS 247 Sect. 5.5	< -20 dBr	- 16.67 dBr (-37.36 dBm at 4882.6 MHz)	**Complied**
RF Exposure for General Population	CFR47 15.247 (i), 2.1091	1.0 mW/cm^2	0.0009674 mW/cm^2	**Complied**

Note: 1. Meet restricted band emission requirements.
2. This report is only documented for 2402 – 2480MHz.

1.4 Special Accessories

No special accessories were necessary in order to achieve compliance.

1.5 Equipment Modifications

None

2 Laboratory Information

2.1 Accreditations & Endorsements

2.1.1 US Federal Communications Commission

TUV Rheinland of North America at 1279 Quarry Ln, Pleasanton, CA 94566 is recognized by the commission for performing testing services for the general public on a fee basis. These laboratory test facilities have been fully described in reports submitted to and accepted by the FCC (US1131). The laboratory scope of accreditation includes: Title 47 CFR Parts 15, 18, and 90. The accreditation is updated every 3 years.

2.1.2 NIST / A2LA

TUV Rheinland of North America is accredited by the National Voluntary Laboratory Accreditation Program, which is administered under the auspices of the National Institute of Standards and Technology. The laboratory has been assessed and accredited in accordance with ISO Guide 17025:2005 and ISO 9002 (Lab Code 3331.02). The scope of laboratory accreditation includes emission and immunity testing. The accreditation is updated annually.

2.1.3 Canada – Industry Canada

TUV Rheinland of North America at the 1279 Quarry Ln, Pleasanton, CA 94566 address is accredited by Industry Canada for performing testing services for the general public on a fee basis. This laboratory test facilities have been fully described in reports submitted to and accepted by Industry Canada (File Number 2932M). This reference number is the indication to the Industry Canada Certification Officers that the site meets the requirements of RSS 212, Issue 1 (Provisional). The accreditation is updated every 3 years.

2.1.4 Japan – VCCI

The Voluntary Control Council for Interference by Information Technology Equipment (VCCI) is a group that consists of Information Technology Equipment (ITE) manufacturers and EMC test laboratories. The purpose of the Council is to take voluntary control measures against electromagnetic interference from Information Technology Equipment, and thereby contribute to the development of a socially beneficial and responsible state of affairs in the realm of Information Technology Equipment in Japan. TUV Rheinland of North America at 1279 Quarry Ln, Pleasanton, CA 94566 has been assessed and approved in accordance with the Regulations for Voluntary Control Measures.

VCCI Registration No. for Pleasanton: A-0261

2.1.5 Acceptance by Mutual Recognition Arrangement

The United States has an established agreement with specific countries under the Asia Pacific Laboratory Accreditation Corporation (APLAC) Mutual Recognition Arrangement. Under this agreement, all TUV Rheinland at 1279 Quarry Ln, Pleasanton, CA 94566 test results and test reports within the scope of the laboratory NIST / A2LA accreditation will be accepted by each member country.

2.2 Test Facilities

All of the test facilities are located at 1279 Quarry Lane, Pleasanton, California 94566, USA.

2.2.1 Emission Test Facility

The Semi-Anechoic chamber and AC Line Conducted measurement facility used to collect the radiated and conducted data has been constructed in accordance with ANSI C63.7:1992. The site has been measured in accordance with and verified to comply with the theoretical normalized site attenuation requirements of ANSI C63.4-2014, at a test distance of 3 and 5 meters. The site is listed with the FCC and accredited by A2LA (Lab Code 3331.02). The 3/5-meter semi-anechoic chamber used to collect the radiated data has been verified to comply with the theoretical normalized site attenuation requirements of ANSI C63.4-2014, at a test distance of 3 meter and 5 meters. A report detailing this site can be obtained from TUV Rheinland of North America.

2.2.2 Immunity Test Facility

ESD, EFT, Surge, PQF: These tests are performed in an environmentally controlled room with a 3.7 m x 4.8 m x 3.175 mm thick aluminum floor connected to PE ground.

For ESD testing, tabletop equipment is placed on an insulated mat with a surface resistivity of 10^9 Ohms/square on a 1.6 m x 0.8 m x 0.8 m high non-conductive table with a 3.175 mm aluminum top (Horizontal Coupling Plane). The HCP is connected to the main ground plane via a low impedance ground strap through two 470-kΩ resistors. The Vertical Coupling Plane consists of an aluminum plate 50 cm x 50 cm x 3.175 mm thick. The VCP is connected to the main ground plane via a low impedance ground strap through two 470-kΩ resistors.

For EFT, Surge, PQF, the HCP and VCP are removed.

RF Field Immunity testing is performed in a 7.3m x 4.3m x 4.1m anechoic chamber.

RF Conducted and Magnetic Field Immunity testing is performed on a 4.8m x 3.7m x 3.175mm thick aluminum ground plane.

All test areas allow a minimum distance of 1 meter from the EUT to walls or conducting objects.

2.3 Measurement Uncertainty

Two types of measurement uncertainty are expressed in this report, per *ISO Guide To The Expression Of Uncertainty In Measurement*, 1st Edition, 1995.

The Combined Standard Uncertainty is the standard uncertainty of the result of a measurement when that result is obtained from the values of a number of other quantities; it is equal to the positive square root of the sum of the variances or co-variances of these other quantities, weighted according to how the measurement result varies with changes in these quantities. The term *standard uncertainty* is the result of a measurement expressed as a standard deviation.

2.3.1 Sample Calculation – radiated & conducted emissions

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

Field Strength (dBμV/m) = RAW - AMP + CBL + ACF

Where: RAW = Measured level before correction (dBμV)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

$$\mu V/m = 10^{\frac{dB\mu V/m}{20}}$$

Sample radiated emissions calculation @ 30 MHz

Measurement +Antenna Factor–Amplifier Gain+Cable loss=Radiated Emissions (dBuV/m)

25 dBuV/m + 17.5 dB – 20 dB + 1.0 dB = 23.5 dBuV/m

2.3.2 Measurement Uncertainty Emissions

Per CISPR 16-4-2	**U_{lab}**	**U_{cispr}**
Radiated Disturbance @ 10 meters		
30 – 1,000 MHz	2.25 dB	4.51 dB
Radiated Disturbance @ 3 meters		
30 – 1,000 MHz	2.26 dB	4.52 dB
1 – 6 GHz	2.12 dB	4.25 dB
6 – 18 GHz	2.47 dB	4.93 dB
Conducted Disturbance @ Mains Terminals		
150 kHz – 30 MHz	1.09 dB	2.18 dB
Disturbance Power		
30 MHz – 300 MHz	3.92 dB	4.3 dB

Voltech PM6000A

The estimated combined standard uncertainty for harmonic current and flicker measurements is ± 5.0%.	Per CISPR 16-4-2 Methods

2.3.3 Measurement Uncertainty Immunity

The estimated combined standard uncertainty for ESD immunity measurements is ± 8.2%.	Per IEC 61000-4-2
The estimated combined standard uncertainty for radiated immunity measurements is ± 4.10 dB.	Per IEC 61000-4-3
The estimated combined standard uncertainty for conducted immunity measurements with CDN is ± 3.66 dB	Per IEC 61000-4-6
The estimated combined standard uncertainty for power frequency magnetic field immunity is ± 11.6%.	Per IEC 61000-4-8

Thermo KeyTek EMC Pro

The estimated combined standard uncertainty for EFT fast transient immunity measurements is ± 5.84%.
The estimated combined standard uncertainty for surge immunity measurements is ± 5.84 %.
The estimated combined standard uncertainty for voltage variation and interruption measurements is ± 3.48%.

The expanded uncertainty at a level of 95% confidence is obtained by multiplying the combined standard uncertainty by a coverage factor of 2. Compliance criteria are not based on measurement uncertainty.

Measurement Uncertainty – Radio Testing

The estimated combined standard uncertainty for frequency error measurements is ± 3.88 Hz
The estimated combined standard uncertainty for carrier power measurements is ± 0.7 dB.
The estimated combined standard uncertainty for adjacent channel power measurements is ± 1.47 dB.
The estimated combined standard uncertainty for modulation frequency response measurements is ± 0.46 dB.
The estimated combined standard uncertainty for transmitter conducted emission measurements is ± 2.06 dB

The expanded uncertainty at a level of 95% confidence is obtained by multiplying the combined standard uncertainty by a coverage factor of 2. Compliance criteria are not based on measurement uncertainty.

2.4 Calibration Traceability

All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Measurement method complies with ANSI/NCSL Z540-1-1994 and ISO Standard 17025:2005.

3 Product Information

3.1 Product Description

JADAK/PRI P/N 6XYZ-0003-01 Bluetooth Module consists of Bluetooth board P/N 1803-0180-00 Rev B2 and Antenna P/N: 1000-0002-86 Rev A.

3.2 Equipment Configuration

A description of the equipment configuration is given in the Test Plan Section. The EUT was tested as called for in the test standard and was configured and operated in a manner consistent with its intended use. The EUT was connected to rated power and allowed to reach intended operating conditions. The placement of the EUT system components was guided by the test standard and selected to represent typical installation conditions.

In the case of a EUT that can operate in more than one configuration, preliminary testing was performed to determine the configuration that produced maximum radiation.

The final configuration was selected to produce the worst case radiation for emissions testing and to place the EUT in the most susceptible state for immunity testing.

3.3 Operating Mode

A description of the operation mode is given in the Test Plan Section. In the case of a EUT that can operate in more than one state, preliminary testing was performed to determine the operating mode that produced maximum radiation.

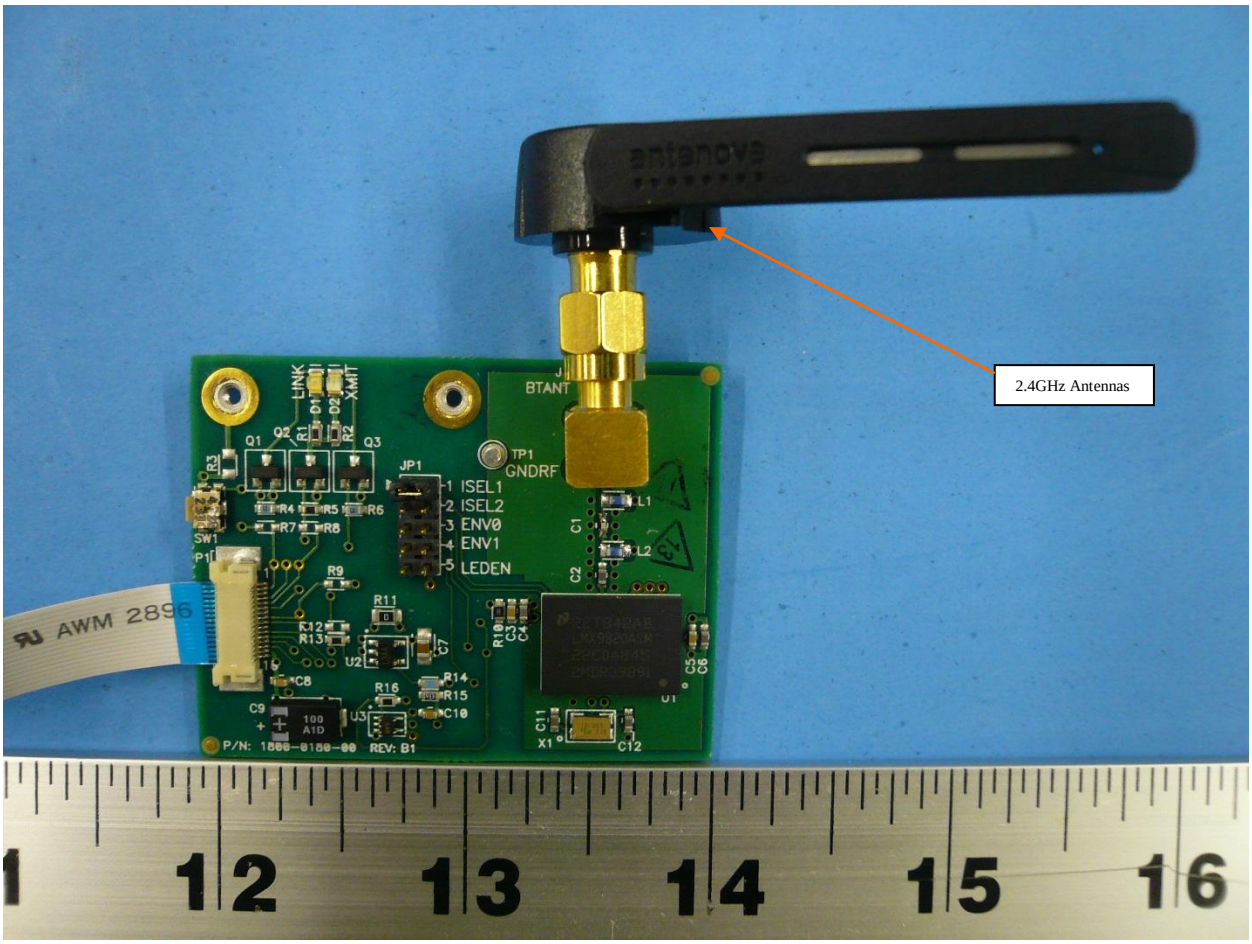
The final operating mode was selected to produce the worst case radiation for emissions testing and to place the EUT in the most susceptible state for immunity testing.

3.4 Unique Antenna Connector

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of CFR47 Parts 15.211, 15.213, 15.217, 15.219, or 15.221.

3.4.1 Results

The JADAK/PRI uses the 4.4dBi SMA connecting antenna.



3.5 Duty Cycle

The JADAK/PRI P/N 6XYZ-0003-01, SN: W31300084 was measured.

3.5.1 Results

Mode	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Factor (dB)
DH1	0.395	1.25	31.6	5.00
DH3	1.645	2.50	65.8	1.82
DH5	2.885	3.74	77.1	1.13
Notes: These modes represent the maximum duty cycle; in which the Bluetooth module will operate.				

4 Emission Requirements – 2400 MHz to 2483.5 MHz Band

Testing was performed in accordance with CFR 47 Part 15.247: 2017 and RSS 247 2017. These test methods are listed under the laboratory's A2LA Scope of Accreditation. This test measures the levels emanating from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices. Procedures described in Section 8 of the standard were used.

4.1 Output Power Requirements

The maximum output power requirement is the maximum equivalent isotropic radiated power delivering at the transmitting antenna under specified conditions of measurements in the presence of modulation.

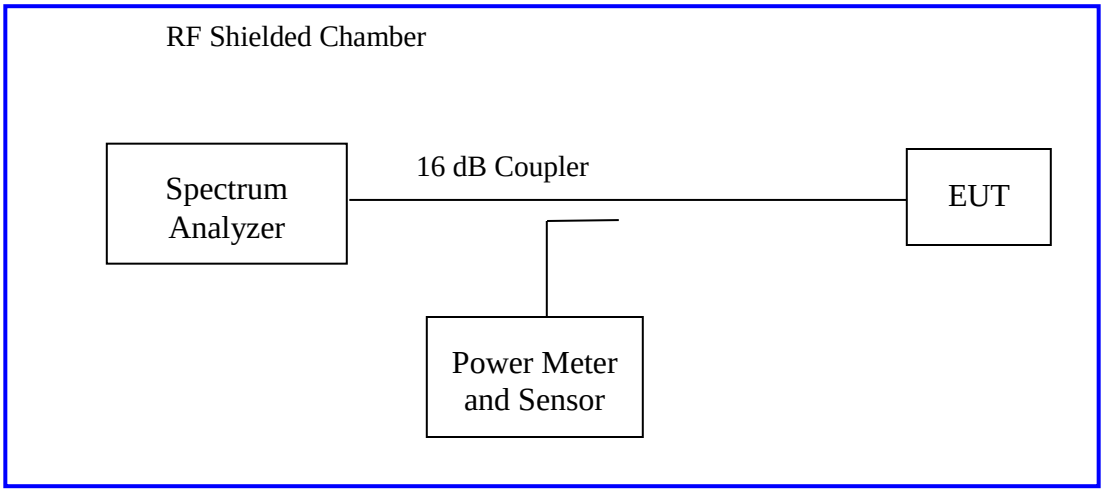
The maximum output power and harmonics shall not exceed CFR47 Part 15.247 (b1) and RSS 247 Sect. 5.4(b).

Frequency hopping systems in the 2400-2483.5 MHz band: 1 watts.

4.1.1 Test Method

The conducted method was used to measure the channel power output according to ANSI C63.10:2013 Section 7.8.5. The measurement was performed with modulation per CFR47 Part 15.247 (b1):2017 and RSS 247 Sect. 5.4(b). This test was conducted on 3 channels on JADAK/PRI P/N 6XYZ-0003-01, SN: W31300084. The worst mode result indicated below.

Test Setup:



4.1.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 2: RF Output Power at the Antenna Port – Test Results

Test Conditions: Conducted Measurement, Normal Temperature			**Date**: May 16, 2017	
Antenna Type: Swivel SMA Antenna			**Power Setting:** Fixed	
Max. Antenna Gain: 4.4 dBi			**Signal State:** Modulated	
Duty Cycle: See Sect. 3.5			**Data Rate:** BDR	
Ambient Temp.: 23º C			**Relative Humidity:** 33 %RH	
802.15.1 Mode				
Package/ Power	**Operating Channel**	**Limit [dBm]**	**Power [dBm]**	**Margin [dB]**
DH1	2402 MHz	+30.00	4.73	-25.27
	2441 MHz	+30.00	4.64	-25.36
	2480 MHz	+30.00	4.56	-25.44
DH3	2402 MHz	+30.00	4.49	-25.51
	2441 MHz	+30.00	4.46	-25.54
	2480 MHz	+30.00	4.40	-25.60
DH5	2402 MHz	+30.00	4.42	-25.58
	2441 MHz	+30.00	4.42	-25.58
	2480 MHz	+30.00	4.37	-25.63
Note: The module is only capable to transmit at BDR. The worst case peak powers at low, middle, and high frequencies are showed below.				

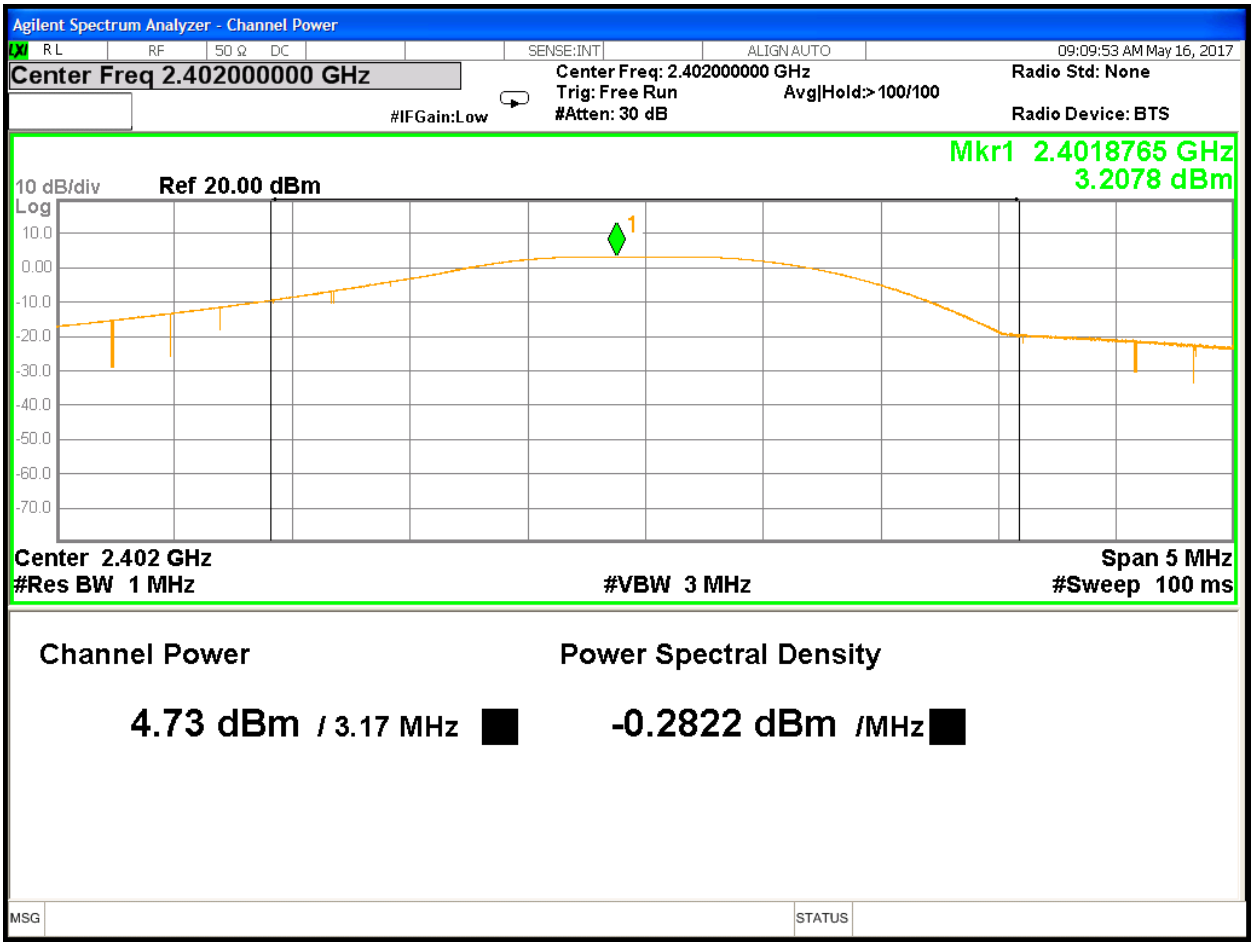


Figure 1: Maximum Transmitted Power, 2402 MHz

Figure 2: Maximum Transmitted Power, 2441 MHz

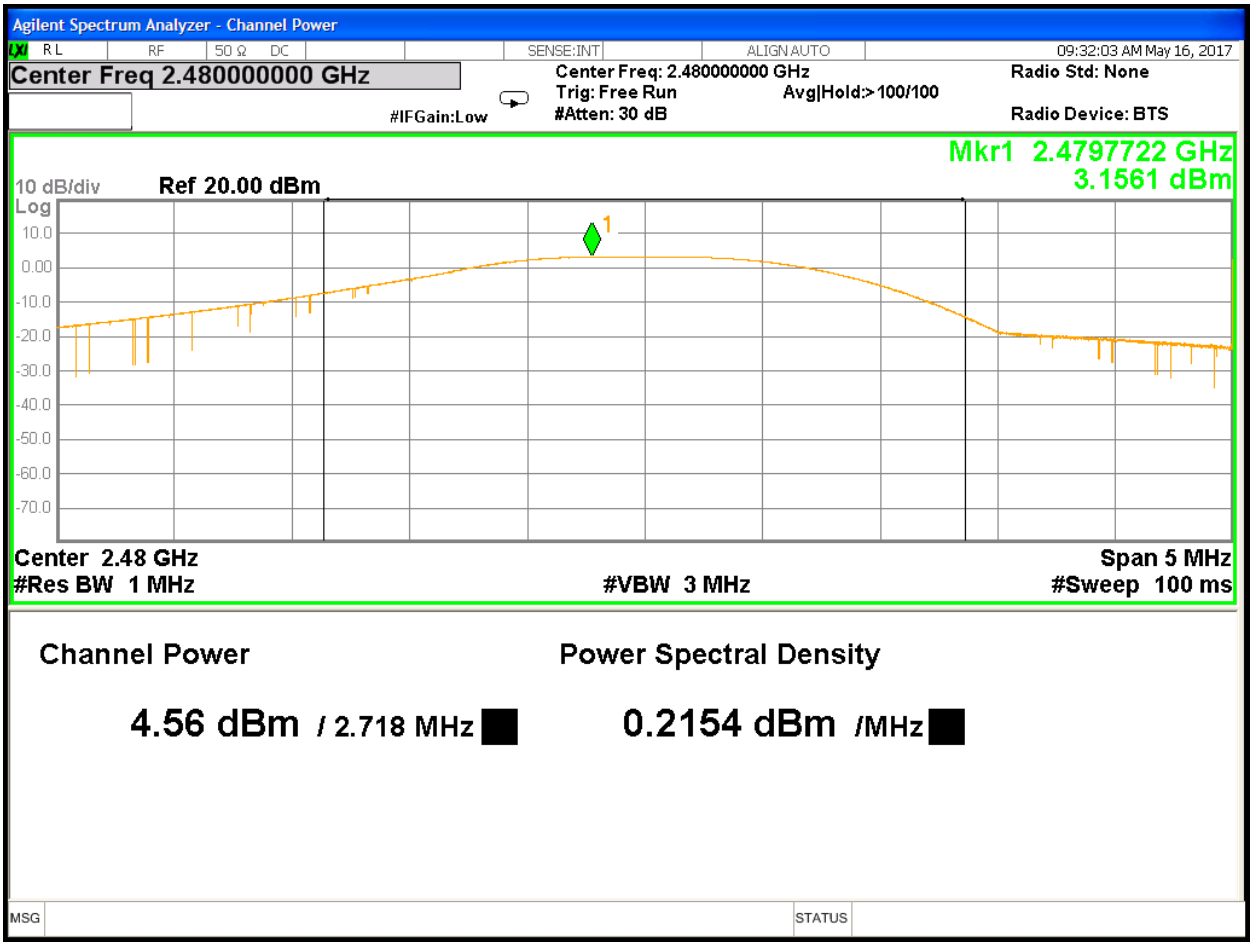


Figure 3: Maximum Transmitted Power, 2480 MHz

4.2 Occupied Bandwidth

The occupied bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at the fundamental frequency.

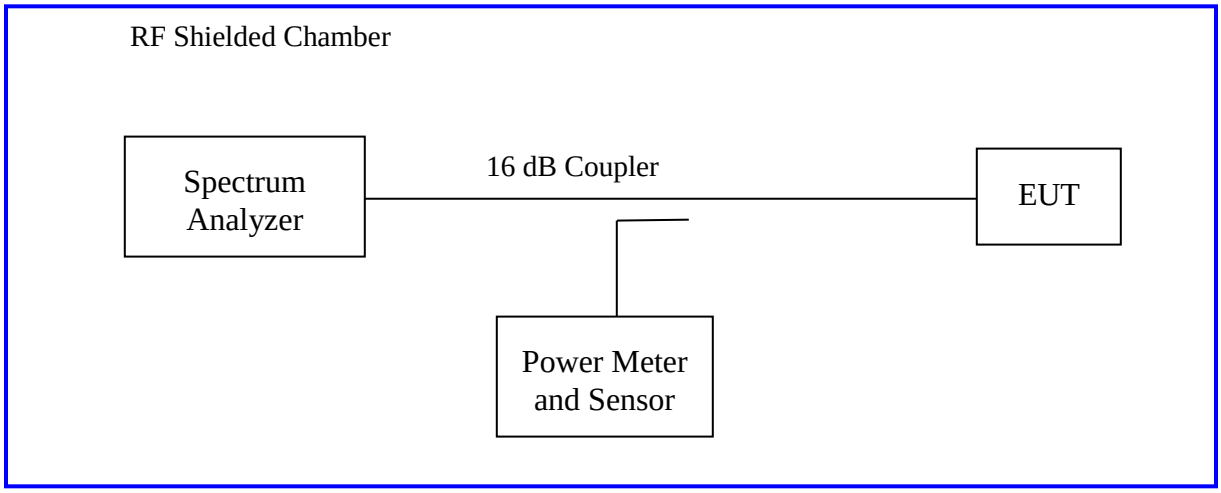
The 99% bandwidth is the bandwidth in which 99% of the transmitted power occupied.

20 dB bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer.

4.2.1 Test Method

The conducted method was used to measure the occupied bandwidth according to ANSI C63.10:2013 Section 6.9. The measurement was performed with modulation per CFR47 15.247(a) (1) 2017 and RSS Gen Sect.6.6. This test was conducted on 3 channels on JADAK/PRI P/N 6XYZ-0003-01, SN: W31300084. The worst sample result indicated below.

Test Setup:



4.2.2 Results

These measurements were used for information only

Table 3: Occupied Bandwidth – Test Results

Test Conditions: Conducted Measurement, Normal Temperature		**Date:** May 16, 2017	
Antenna Type: Swivel SMA Antenna		**Power Setting:** Fixed.	
Max. Antenna Gain: +4.4 dBi		**Signal State:** Modulated	
Duty Cycle: See Sect. 3.5		**Data Rate:** BDR	
Ambient Temp.: 23º C		**Relative Humidity:** 33 %RH	
Bandwidth (MHz)			
Package/ Power	**Freq. (MHz)**	**20dB Bandwidth MHz**	**99% Bandwidth MHz**
DH1	2402	1.028	0.993
	2441	1.034	0.993
	2480	1.032	0.993
DH3	2402	1.031	0.981
	2441	1.029	0.987
	2480	1.030	0.984
DH5	2402	1.027	0.970
	2441	1.030	0.982
	2480	1.033	0.976
Note: The smallest occupied bandwidths are plotted below.			

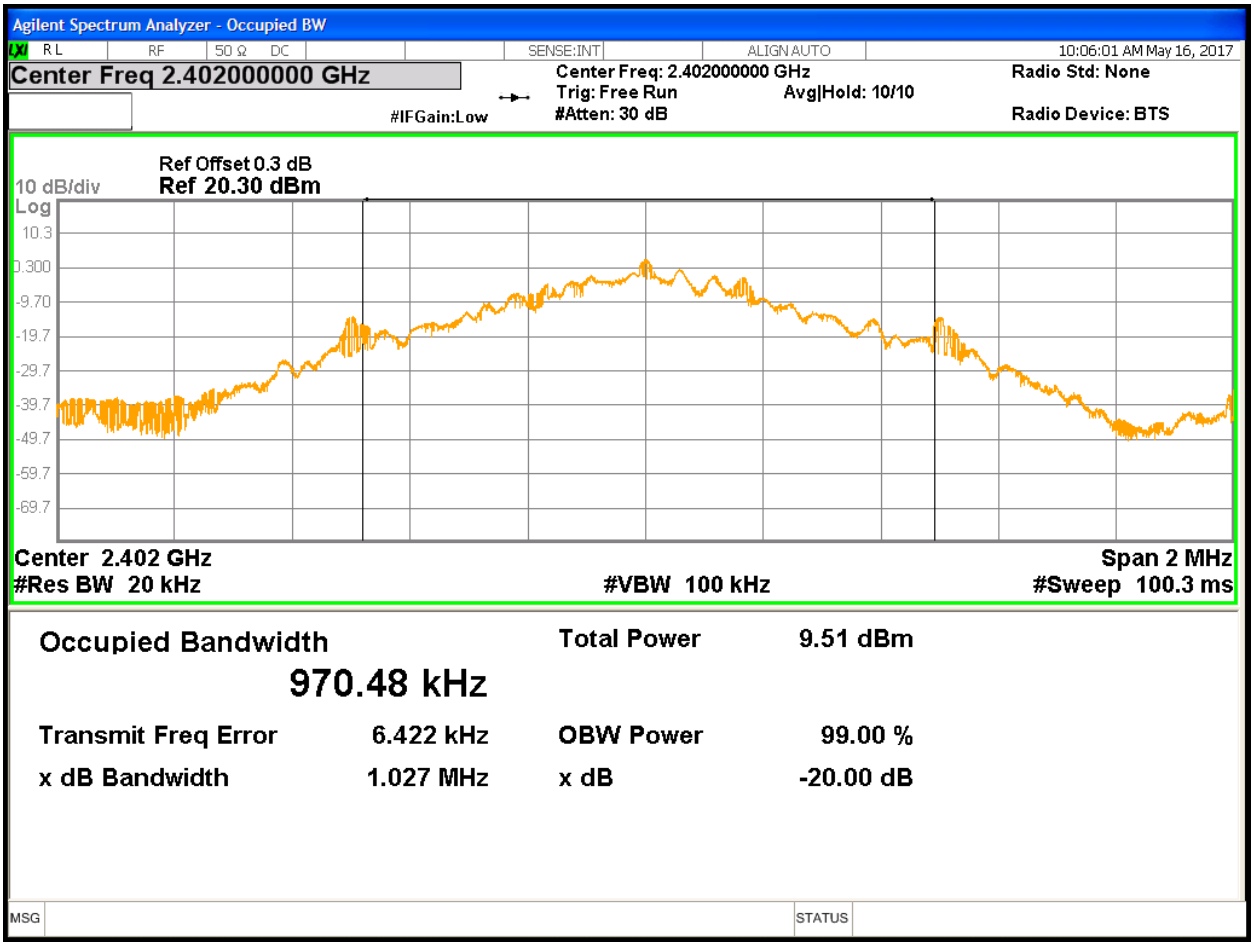


Figure 4: Occupied Bandwidth at 2402 MHz (DH5)

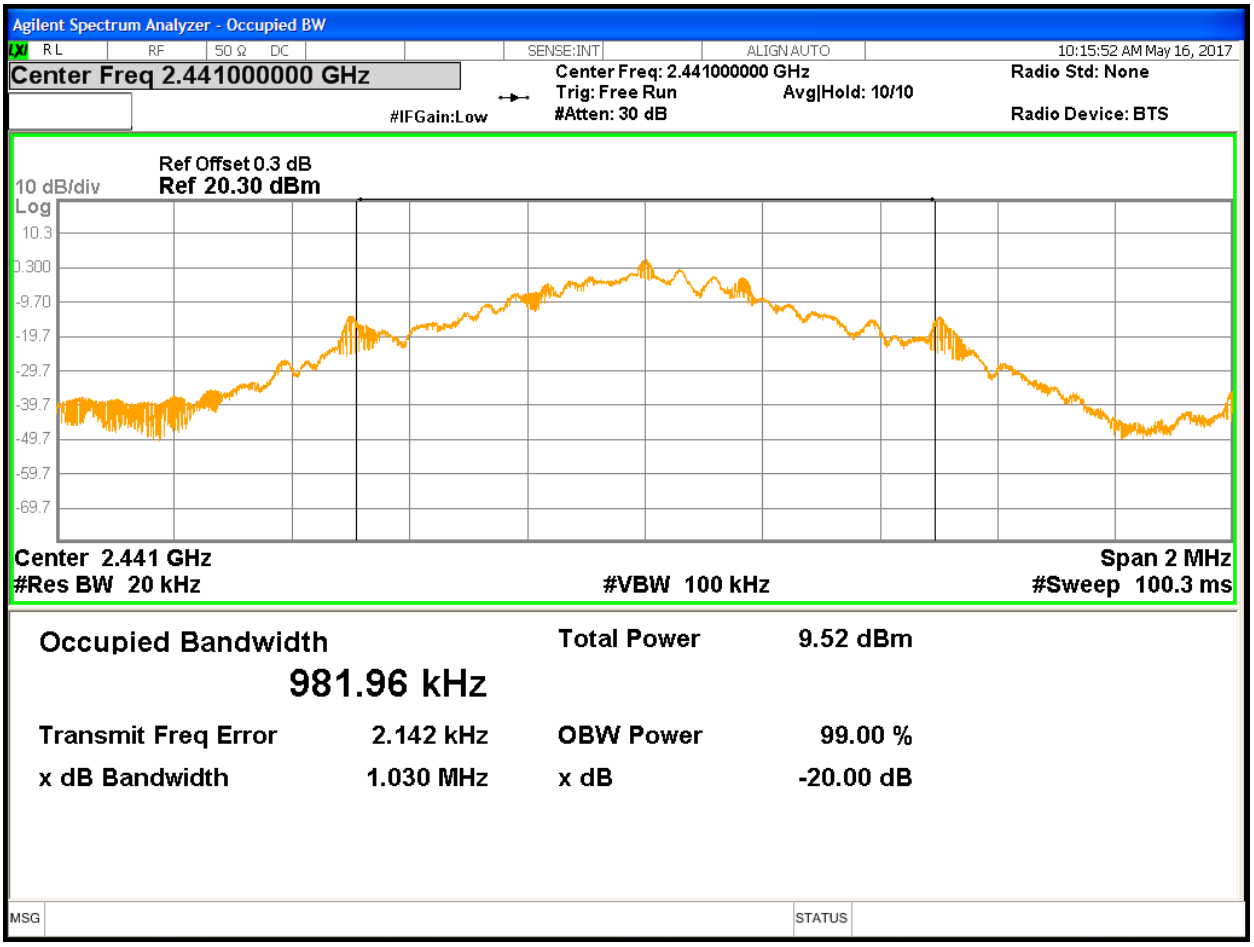


Figure 5: Occupied Bandwidth at 2441 MHz (DH5)

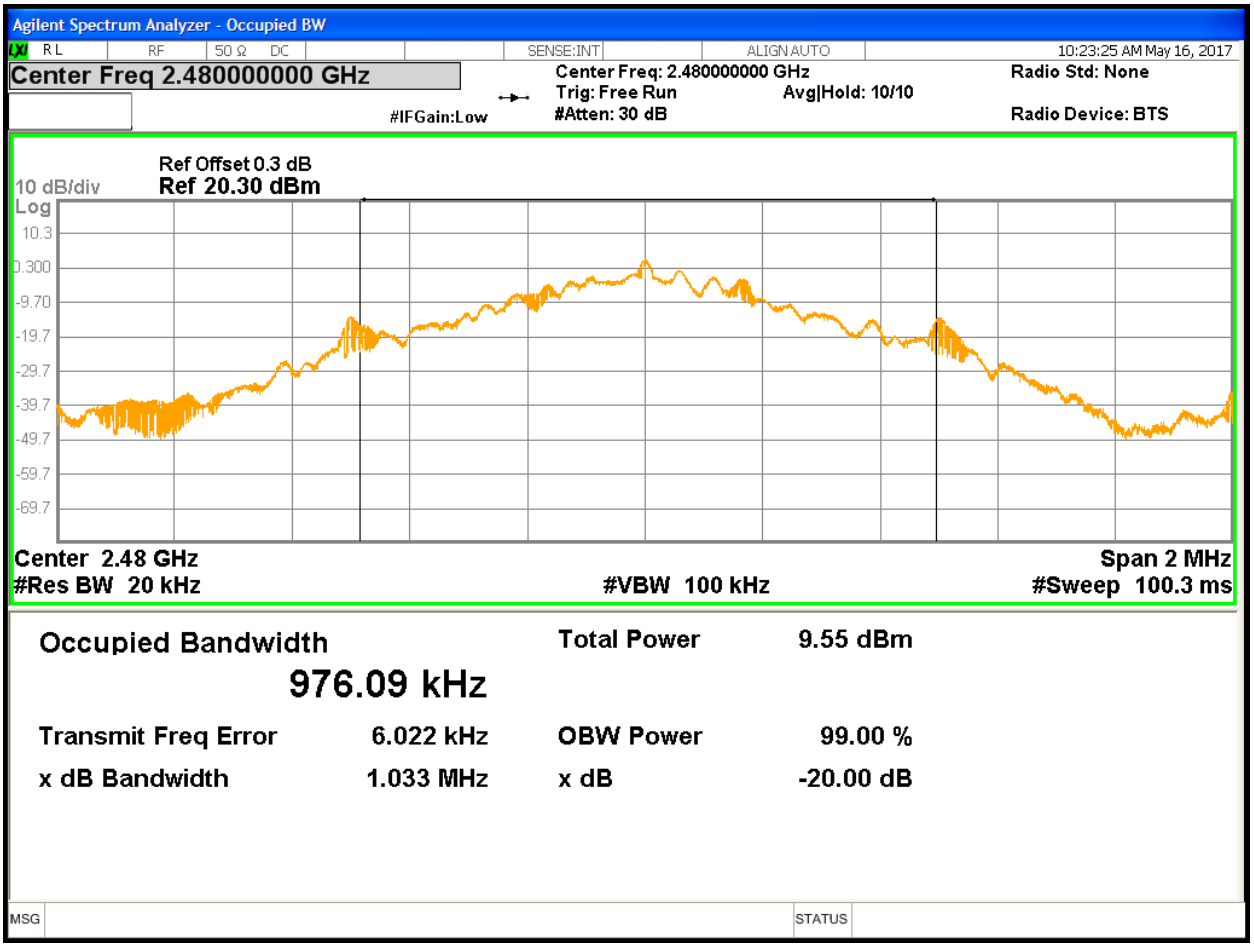


Figure 6: Occupied Bandwidth at 2480 MHz (DH5)

4.3 Hopping Frequency Requirements

The Frequency Hopping Requirements are applicable to the equipment using Frequency Hopping Spread Spectrum (FHSS) modulation.

Per CFR47 15.247 (a1), RSS 247 Sect.5.1(d), frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

The setup was identical to RF output power measurement.

4.3.1 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 4: Frequency Hopping Requirements

Test Conditions: Conducted Measurement, Normal Temperature	**Date:** May 16, 2017
Antenna Type: Swivel SMA Antenna	**Power Setting:** Fixed.
Max. Antenna Gain: +4.4 dBi	**Signal State:** Modulated
Duty Cycle: See Sect. 3.5	**Data Rate:** BDR
Ambient Temp.: 23º C	**Relative Humidity:** 33 %RH

Average Occupancy Time					
Package/ Power	**Pulse Width (ms)**	**# of Pulses (3.16s)**	**Ave. Time (ms)**	**Limit (s)**	**Result**
DH1	0.383	31	118.73	< 0.4	Pass
DH3	1.629	16	260.64	< 0.4	Pass
DH5	2.878	11	316.66	< 0.4	Pass

Note: Since the dwell time in each channel must less than 0.4 seconds. The total time for dwell all 79 channels is 31.6 seconds. To determine the average dwell time, the frequency 2441MHz was sample in 3.16 second, 1/10th of the total 79 channel dwell time.

Minimum Channel Separation			
Package/ Power	**Hopping Separation (kHz)**	**Two-Third of 20dB Bandwidth Limit (kHz)**	**Result**
DH1	1007	> 0.685 kHz	Pass
DH3	1010	> 0.686 kHz	Pass
DH5	990.3	> 0.685 kHz	Pass
Note: The EUT was hopping randomly all 79 operating channels. The channel separation was measured at the one of the middle channels for each mode. Two-Third of the highest 20dB bandwidth was used.			

Minimum Number of Channels		
Range (2402MHz -2480MHz)	**Min. Channel Limit**	**Result**
79	15	Pass
Note: BDR used the 79 hopping channels.		

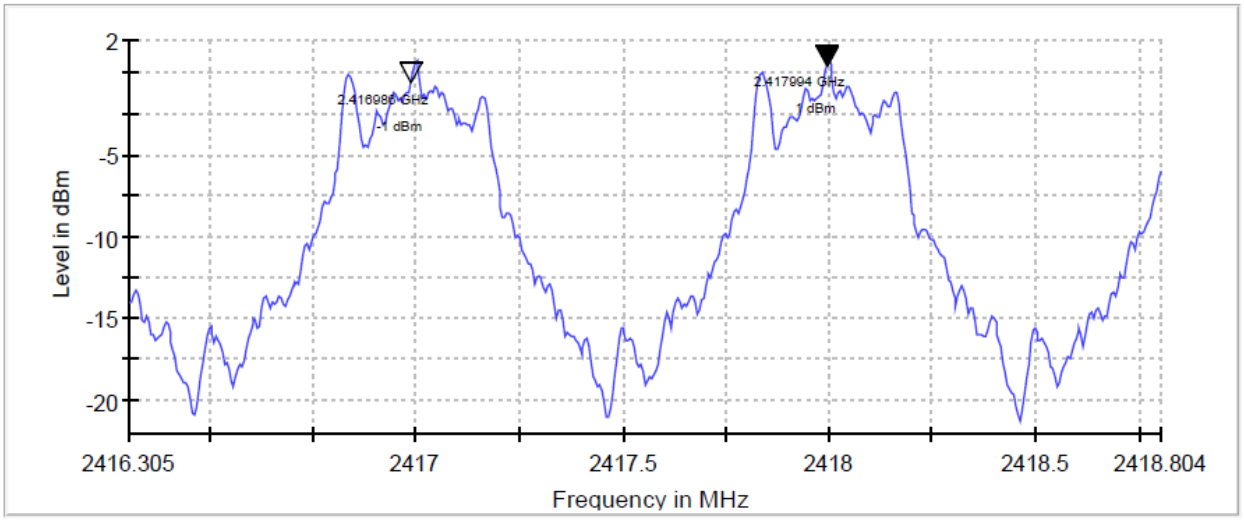


Figure 7: Hopping Separation for DH1

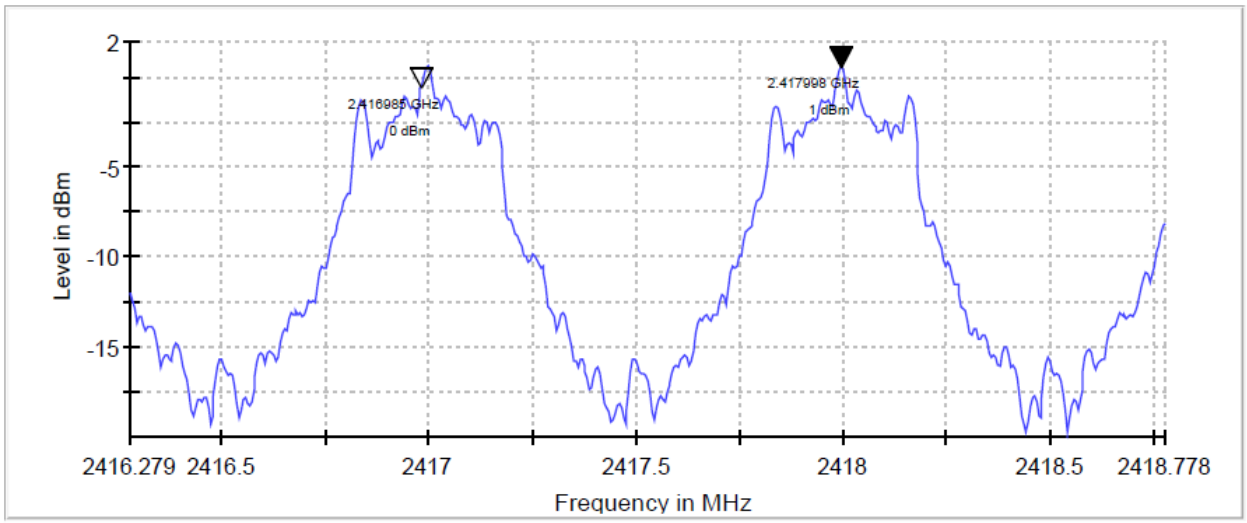


Figure 8: Hopping Separation for DH3

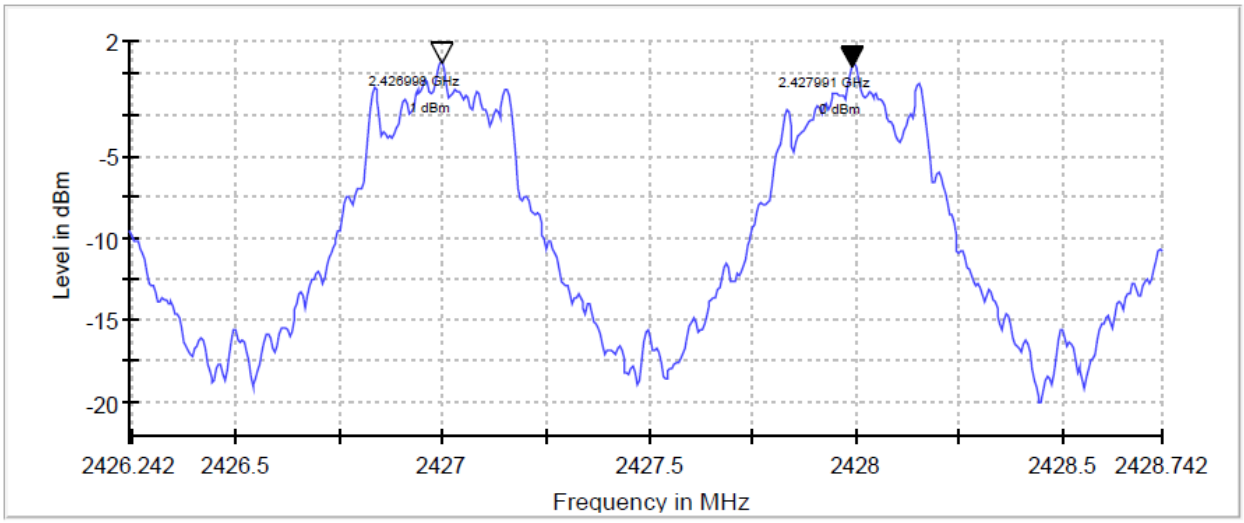


Figure 9: Hopping Separation for DH5

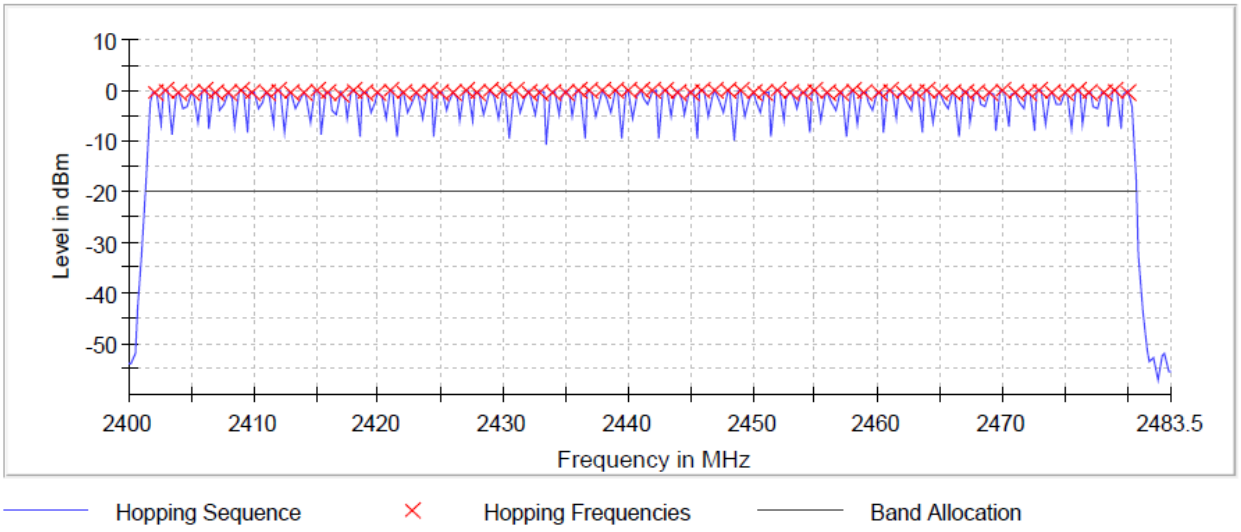


Figure 10: Number of Operating Channels (79)

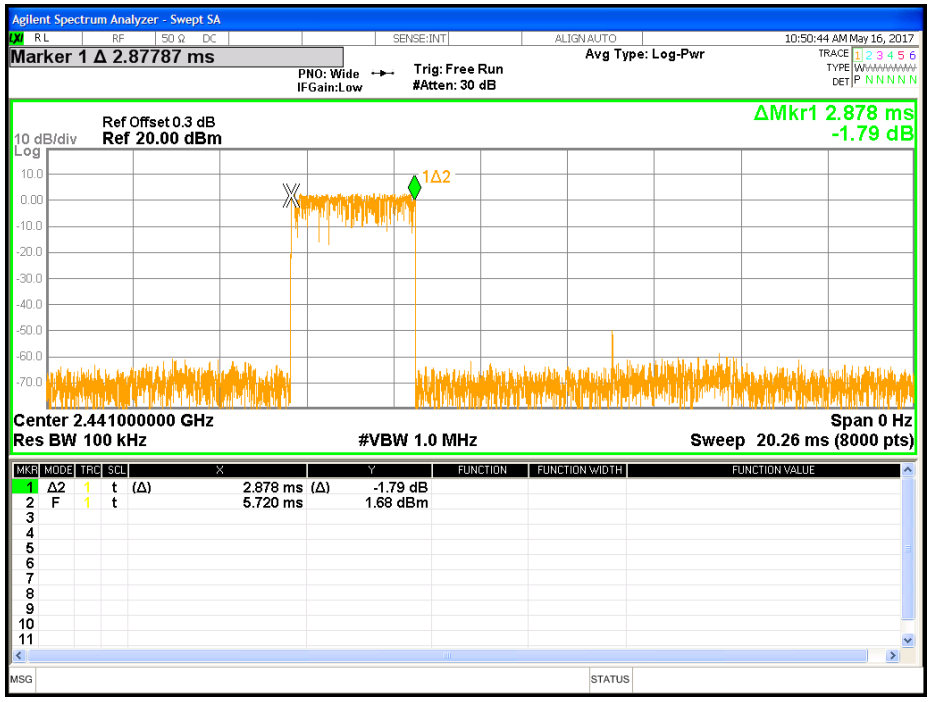


Figure 11: Pulse Width at 2441MHz for DH5

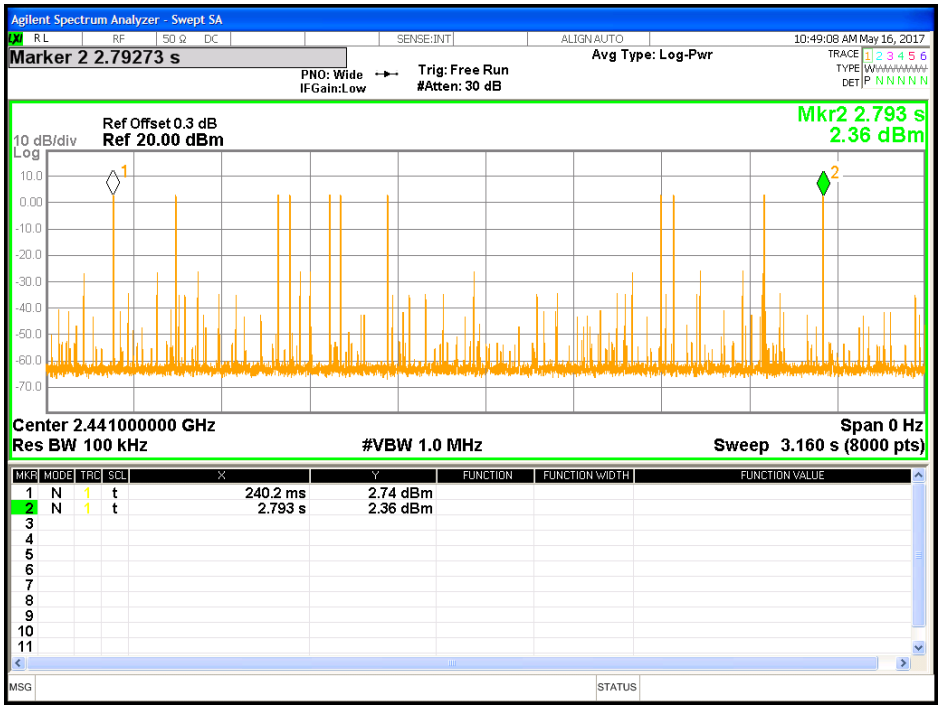


Figure 12: Average Dwell Time for Channel 2441MHz – 11 Pulses (DH5)

Note: There are 11 pulses in 3.16 seconds.

4.4 Out of Band Emission requirements

The setup was identical to RF output power measurement. Intentional radiators operating under the alternative provisions to the general emission limits, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If the frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

Any frequency outside the band of 2400 MHz to 2483.5 MHz, the power output level must be below 20 dB from the in-band transmitting signal; CFR 47 Part 15.215, 15.247(d) and RSS 247 Sect.5.5.

The setup was identical to RF output power measurement.

This test was conducted on 3 channels on JADAK/PRI P/N 6XYZ-0003-01, SN: W31300084.

4.1.1 **Results**

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 5: Band Edge Requirements – Test Results

Test Conditions: Conducted /Normal Temperature			**Date:** May 16, 2017	
Antenna Type: Swivel SMA Antenna			**Power Setting:** Fixed.	
Max. Antenna Gain: +4.4 dBi			**Signal State:** Modulated	
Duty Cycle: See Sect. 3.5			**Data Rate:** BDR	
Ambient Temp.: 23º C			**Relative Humidity:** 33 %RH	
-20 dBr Band Edge Results				
Package/ Power	**Operating Freq.**	**Limit (dBm)**	**Measured Value (dBm)**	**Result**
DH1	2402 MHz	-17.04	-33.94	Pass
	2441 MHz	-16.67	-62.93	Pass
	2480 MHz	-17.00	-48.95	Pass
DH3	2402 MHz	-16.84	-34.41	Pass
	2441 MHz	-16.82	-60.90	Pass
	2480 MHz	-17.11	-49.27	Pass

DH5	2402 MHz	-17.14	-49.17	Pass
	2441 MHz	-17.15	-61.88	Pass
	2480 MHz	-17.27	-50.57	Pass
Note: The stated limits for 20 dBr are relative to each individual mode. The worst case was DH1, and plots show below.				

Out of Band Emission				
Package/ Power	**Operating Freq.**	**Limit (dBm)**	**Measured Value (dBm)**	**Result**
DH1	2402 MHz	-17.04	-43.40 dBm (4804.00MHz)	Pass
	2441 MHz	-16.67	-37.36 dBm (4882.60MHz)	Pass
	2480 MHz	-17.00	-39.27 dBm (4960.00MHz)	Pass
DH3	2402 MHz	-16.84	-37.59 dBm (4804.00MHz)	Pass
	2441 MHz	-16.82	-38.58 dBm (4882.00MHz)	Pass
	2480 MHz	-17.11	-38.08 dBm (4960.00MHz)	Pass
DH5	2402 MHz	-17.14	-38.43 dBm (4804.00MHz)	Pass
	2441 MHz	-17.15	-40.52 dBm (4881.90MHz)	Pass
	2480 MHz	-17.27	-40.53 dBm (4960.00MHz)	Pass
Note: The stated limits are relative to each individual mode.				

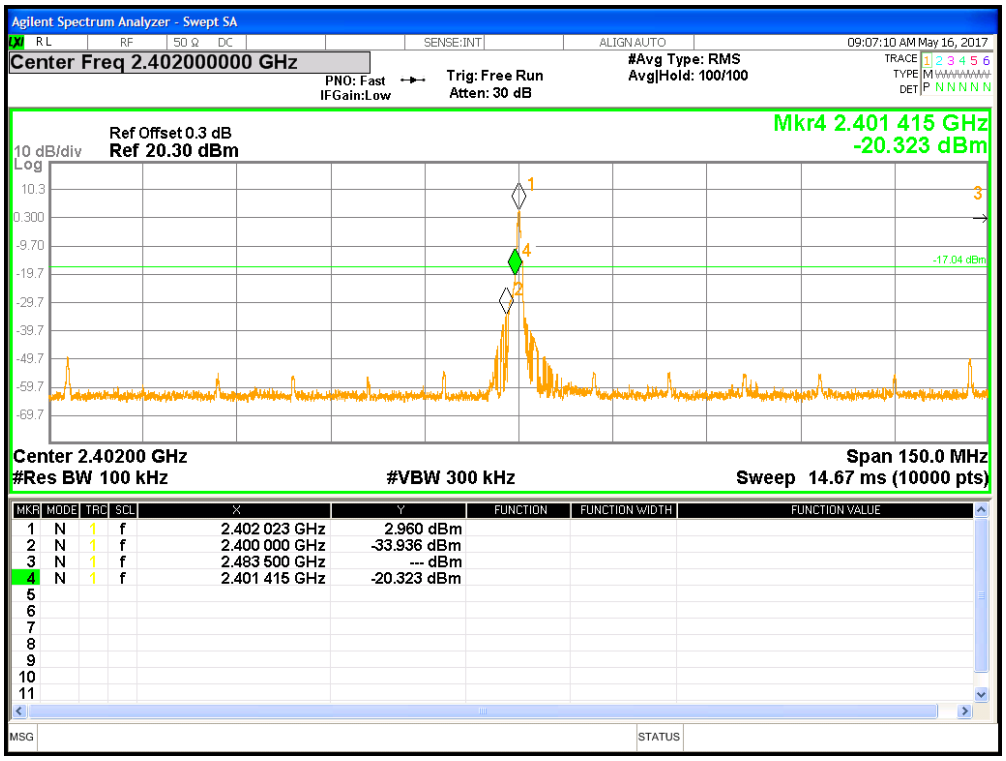


Figure 13: Band Edge Requirements at 2402 MHz – DH1

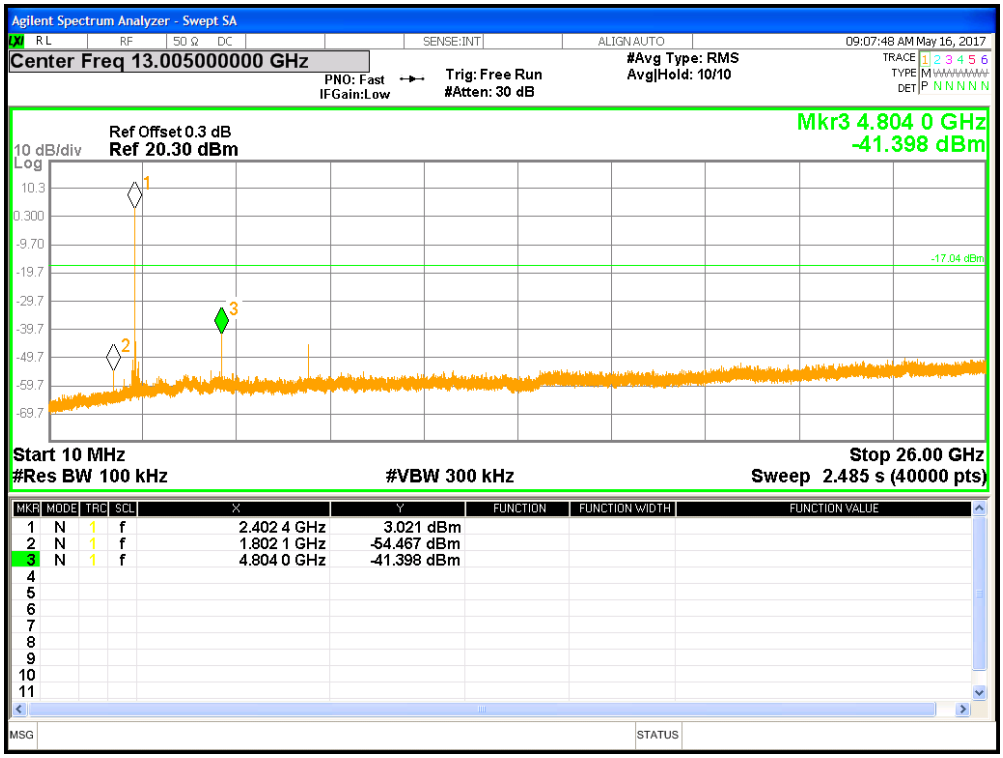


Figure 14: Out of Band Emission Requirements at 2402 MHz – DH1

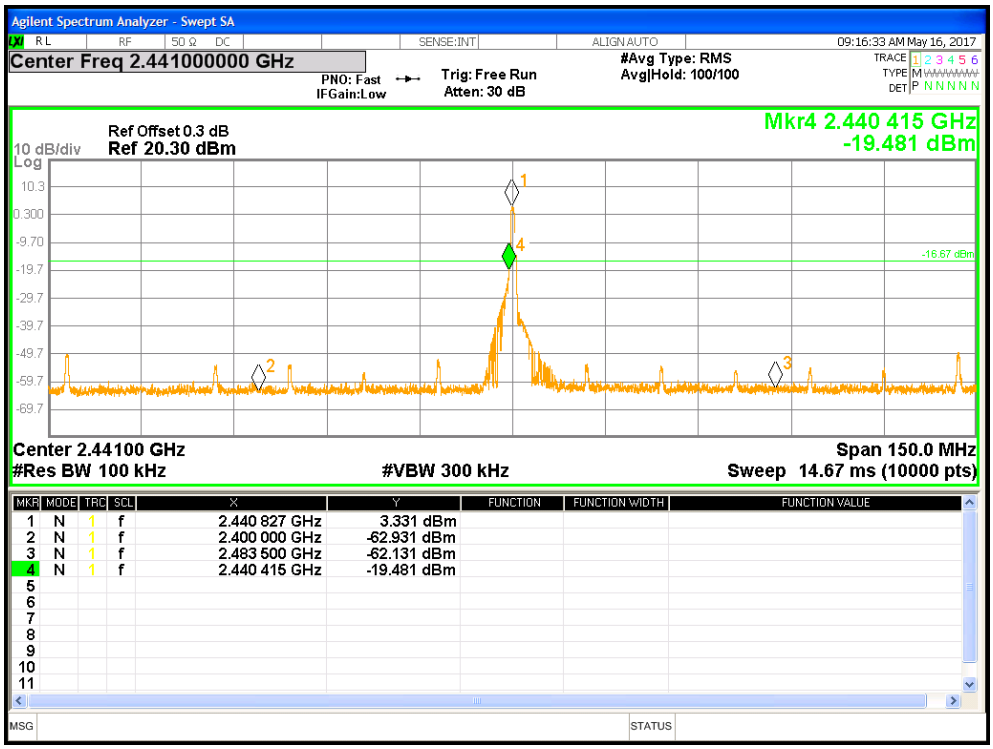


Figure 15: Band Edge Requirements at 2442 MHz – DH1

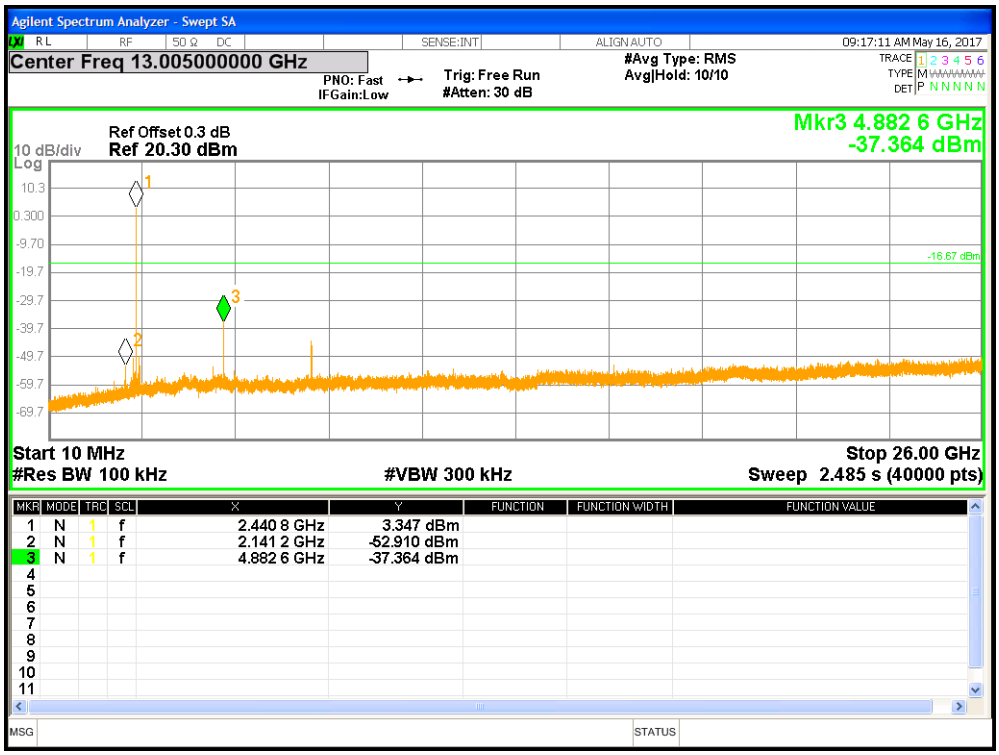


Figure 16: Out of Band Emission Requirements at 2442 MHz – DH1

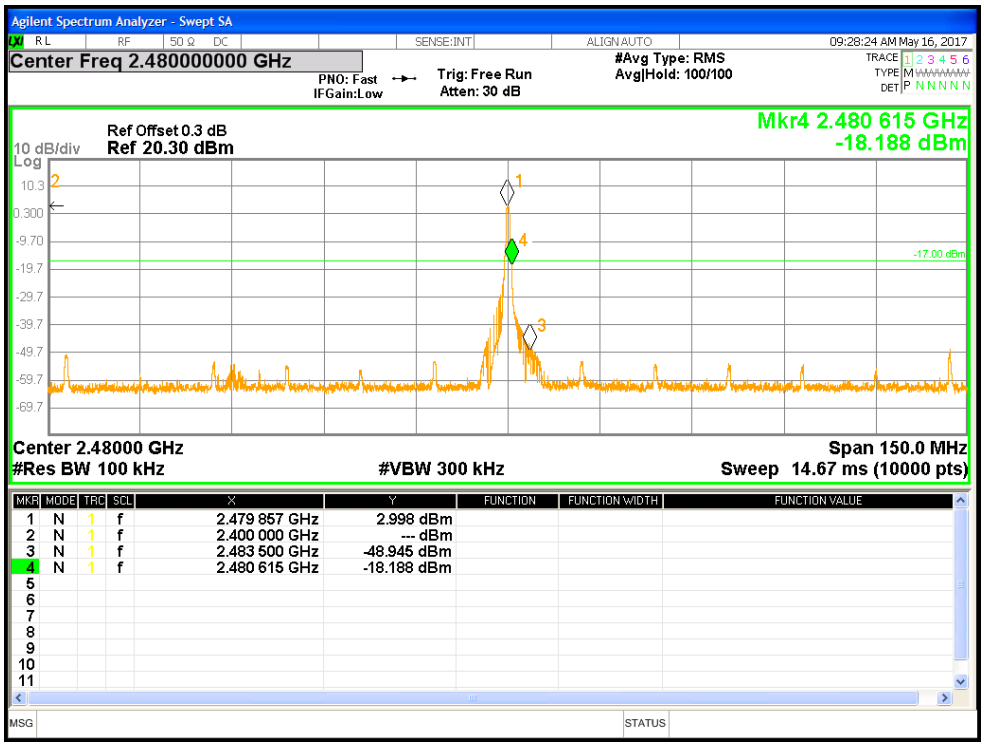


Figure 17: Band Edge Requirements at 2480 MHz – DH1

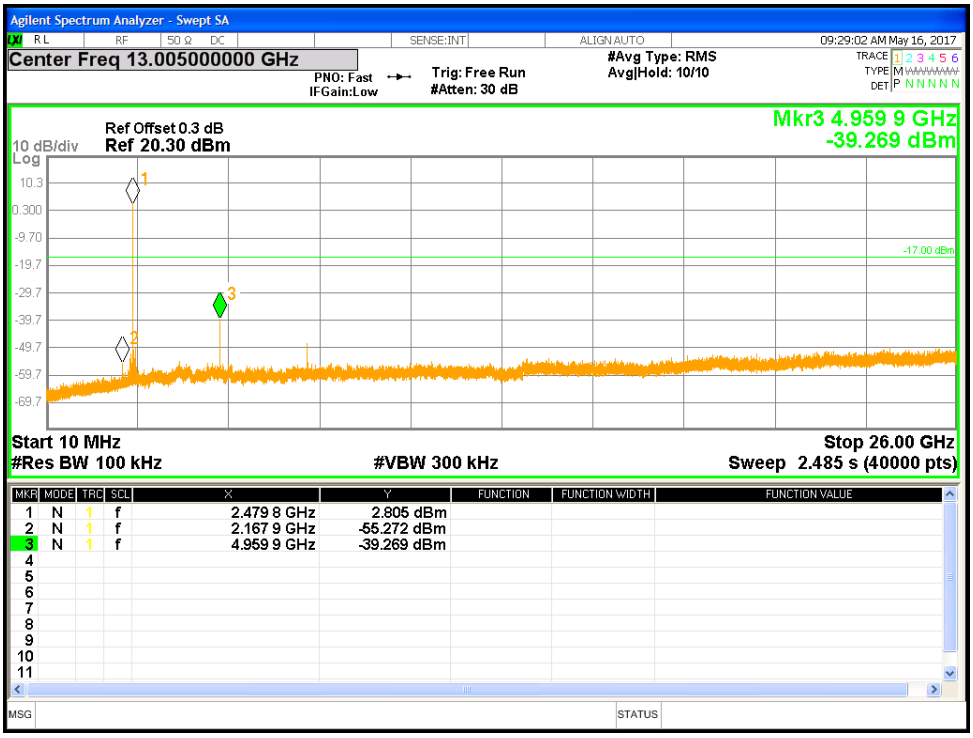


Figure 18: Out of Band Emission Requirements at 2480 MHz – DH1

4.5 Transmitter Spurious Emissions

Transmitter spurious emissions are emissions outside the frequency range of the equipment when the equipment is in transmitting mode; per requirement of CFR47 15.205, 15.209, 15.247(d), RSS-Gen Sect. 6.13.

4.5.1 Test Methodology

4.5.1.1 Preliminary Test

A test program that controls instrumentation and data logging was used to automate the preliminary RF emission test procedure. The frequency range of interest was divided into sub-ranges to yield a frequency resolution of approximately 120 kHz and provide a reading at each frequency for no more than 12° of turntable rotation. For each frequency sub-range the turntable was rotated 360° while peak emission data was recorded and plotted over the frequency range of interest in horizontal and vertical antenna polarization's.

Preliminary emission profile testing was performed inside the anechoic chamber. The EUT was placed on a 1.0m x 1.5m non-conductive table, 80cm above the floor for 30 MHz to 1 GHz and 150cm above the floor for 1 GHz to 26 GHz. The EUT was positioned as shown in the setup photographs. The receiving antenna was placed at a distance of 3m at a fixed height of 1m. Measurement equipment was located outside of the chamber. A video camera was placed inside the chamber to view the EUT.

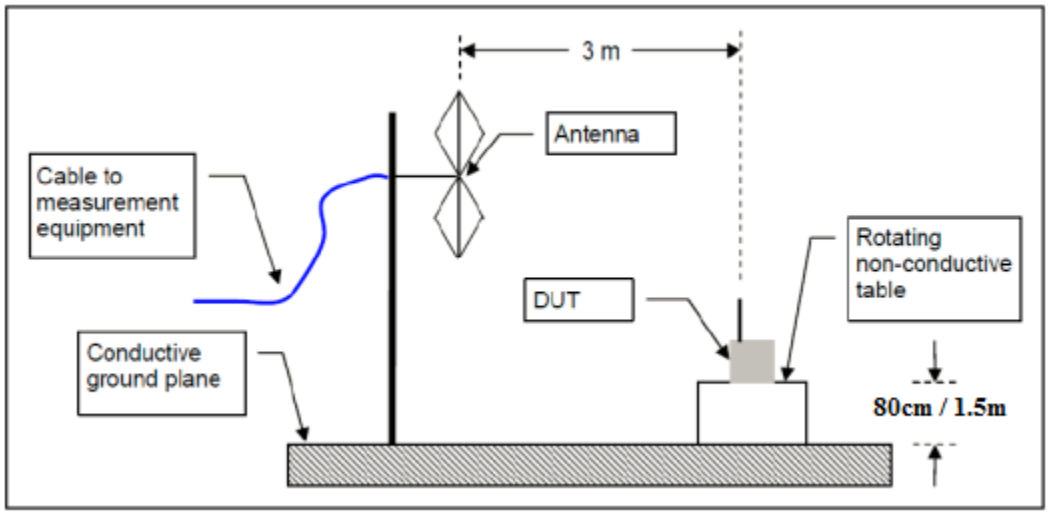
4.5.1.2 Final Test

For each frequency measured, the peak emission was maximized by manipulating the receiving antenna from 1 to 4 meters above the ground plane and placing it at the position that produced the maximum signal strength reading. The turntable was then rotated through 360° while observing the peak signal and placing the EUT at the position that produced maximum radiation. The six highest emissions relative to the limit were measured unless such emissions were more than 20 dB below the limit. If less than six emissions are within 20 dB of the limit, than the noise level of the receiver is measured at frequencies where emissions are expected. Multiples of all oscillator and microprocessor frequencies were also checked.

Final testing was performed on an NSA compliant test site. The EUT was placed on a 1.0m x 1.5m non-conductive table, 80cm above the floor for 30 MHz to 1 GHz and 150cm above the floor for 1 GHz to 26 GHz. The placement of EUT and cables were the same as for preliminary testing and is shown in the setup photographs.

The final scans performed on the worst axis, Z-Axis, for three operating channels: 2402 MHz, 2441 MHz, and 2480 MHz at DH5.

4.5.1.3 Test Setup



4.5.1.4 Deviations

None.

4.5.1.5 Transmitter Spurious Emission Limit

The spurious emissions of the transmitter shall not exceed the values in CFR47 Part 15.205, 15.209: 2017 and RSS –Gen Sect.6.13: 2014.

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490.....	2400/F(kHz)	300
0.490-1.705.....	24000/F (kHz)	30
1.705-30.0.....	30	30
30-88.....	100 **	3
88-216.....	150 **	3
216-960.....	200 **	3
Above 960.....	500	3

All harmonics and spurious emission which are outside of the restricted band shall be 20 dB below the in-band emission.

4.5.1.6 Test Results

The final measurement data was taken under the worst case operating modes, configurations, and/or cable positions. It also reflects the results including any modifications and/or special accessories listed in Sections 1.4 and Test Plan.

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 6: Transmit Spurious Emission at Restricted Band Edge Requirements

Test Conditions: Radiated Measurement at 3 meters	**Date:** May 17, 2017 and October 10, 2017
Antenna Type: Swivel SMA Antenna	**Power Setting:** Fixed.
Max. Antenna Gain: +4.4 dBi	**Signal State:** Modulated
Duty Cycle: 77.1 %	**Data Rate:** BDR (DH5)
Ambient Temp.: 23º C	**Relative Humidity:** 30 %RH

Band Edge Results

Freq. MHz	Level dBuV/m	Pol. V/H	15.209/15.247 Limit	Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
2390	56.23	H	74.00	−17.77	Pk	260	233	TX at 2402 MHz, DH5
2390	42.50	H	54.00	−11.50	Ave	260	233	TX at 2402 MHz, DH5
2390	56.97	V	74.00	−17.03	Pk	232	136	TX at 2402 MHz, DH5
2390	43.69	V	54.00	−10.31	Ave	232	136	TX at 2402 MHz, DH5
2483.5	59.61	V	74.00	−14.39	Pk	205	133	TX at 2480 MHz, DH5
2483.5	50.05	V	54.00	−3.95	Ave	205	133	TX at 2480 MHz, DH5
2483.5	57.06	H	74.00	−16.94	Pk	198	228	TX at 2480 MHz, DH5
2483.5	45.03	H	54.00	−8.97	Ave	198	228	TX at 2480 MHz, DH5
2390	48.18	H	74.00	−25.82	Pk	260	233	Hopping, DH5
2390	37.23	H	54.00	−16.77	Ave	260	233	Hopping, DH5
2483.5	48.85	H	74.00	−25.15	Pk	260	233	Hopping, DH5
2483.5	37.30	H	54.00	−16.70	Ave	260	233	Hopping, DH5
2390	48.33	V	74.00	−25.67	Pk	205	133	Hopping, DH5
2390	37.24	V	54.00	−16.76	Ave	205	133	Hopping, DH5
2483.5	49.04	V	74.00	−24.96	Pk	205	133	Hopping, DH5
2483.5	37.30	V	54.00	−16.70	Ave	205	133	Hopping, DH5

Note: 1. The DH5 was the worst case when tested in the host device.
2. Since the band-edge measurements have good margins in the presence of in-band leakage, the band-edge plots were captured with the spectrum analyzer's span wider than 2 MHz; showing additional sideband spurious emissions.
3. All the band-edge measurements met the restricted band requirements of CFR47 15.205.

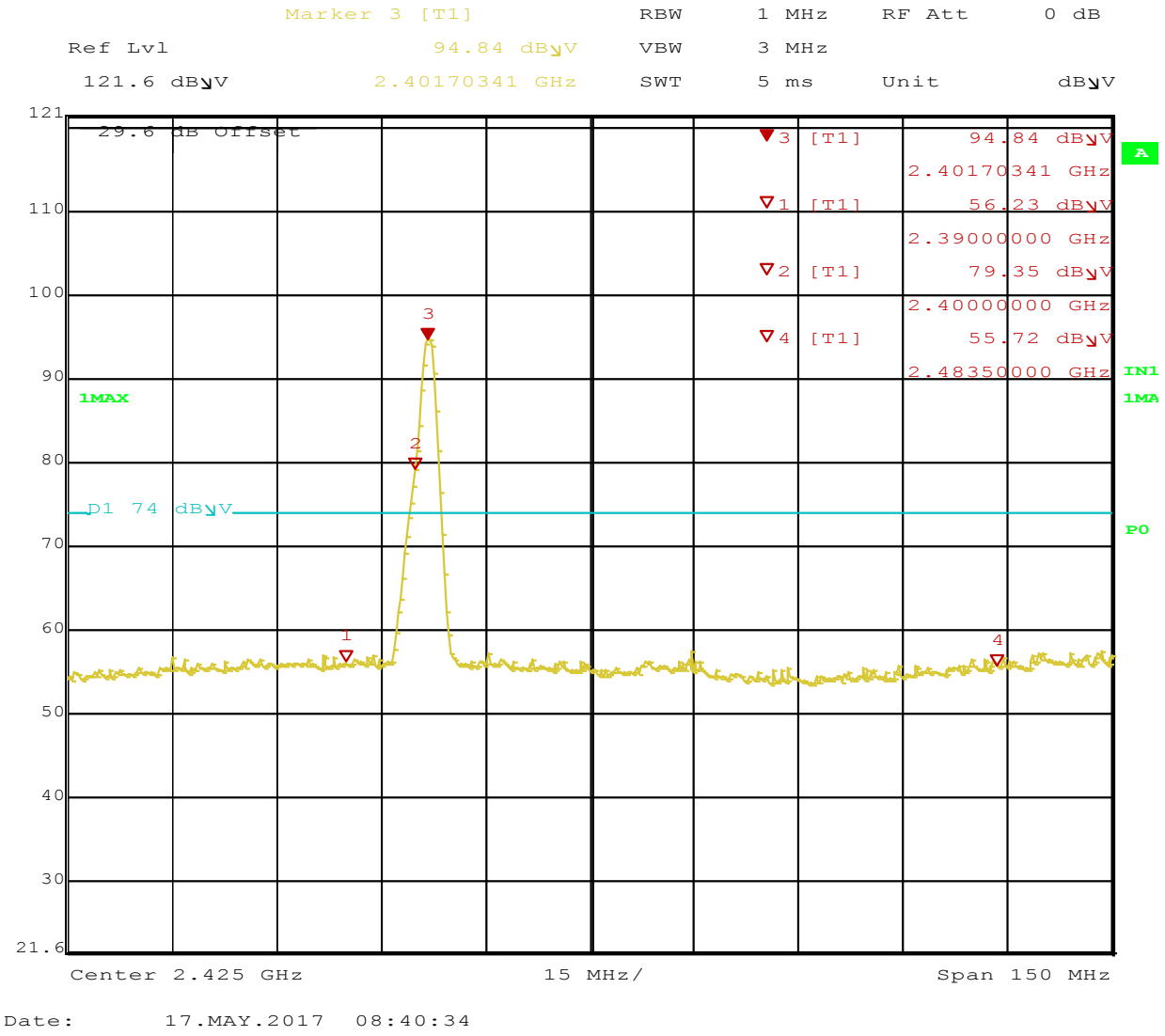


Figure 19: Radiated Emission at the Edge for Channel 2402 MHz at DH5 – Horizontal (Peak)

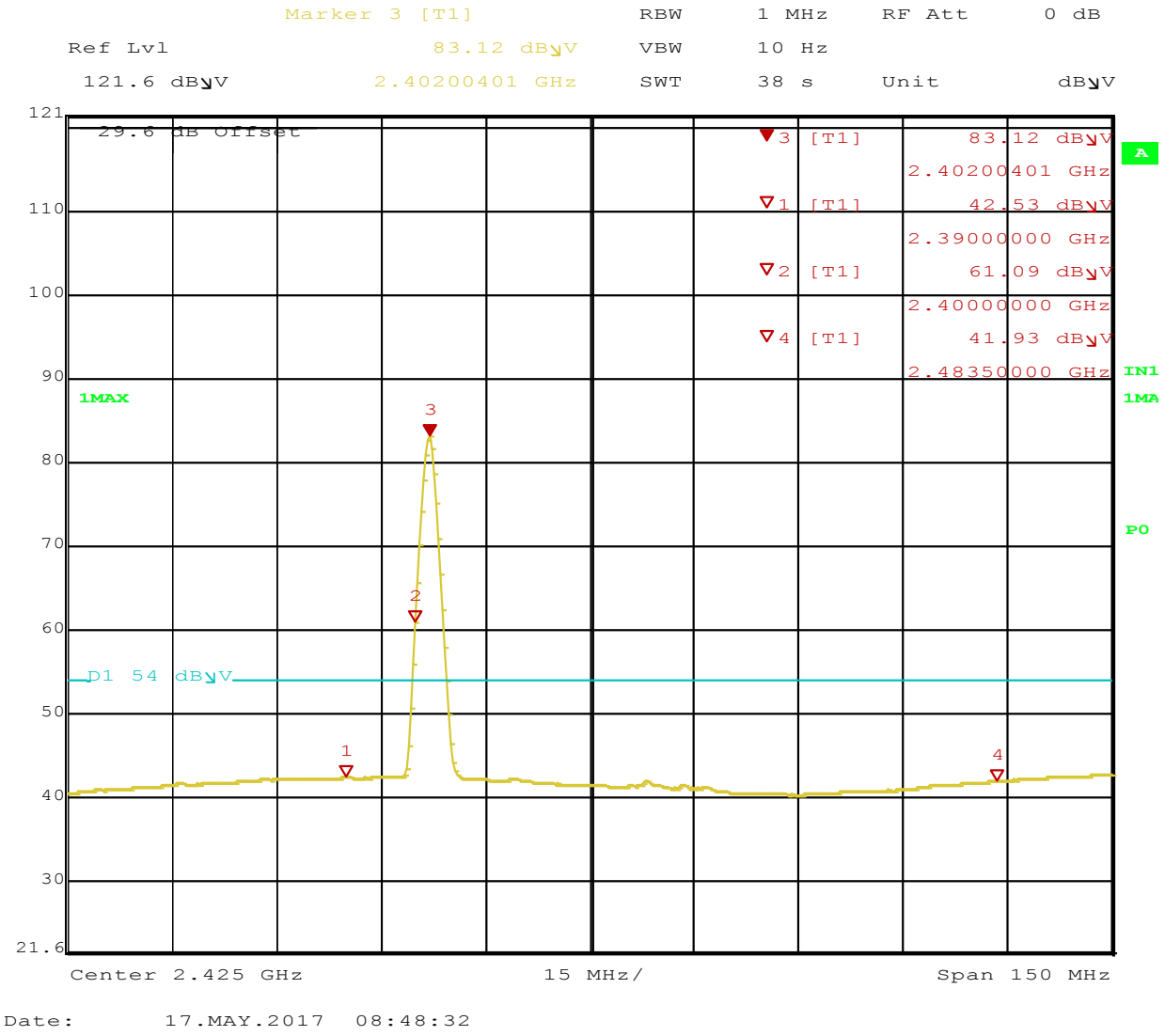


Figure 20: Radiated Emission at the Edge for Channel 2402 MHz at DH5 – Horizontal (Avg)

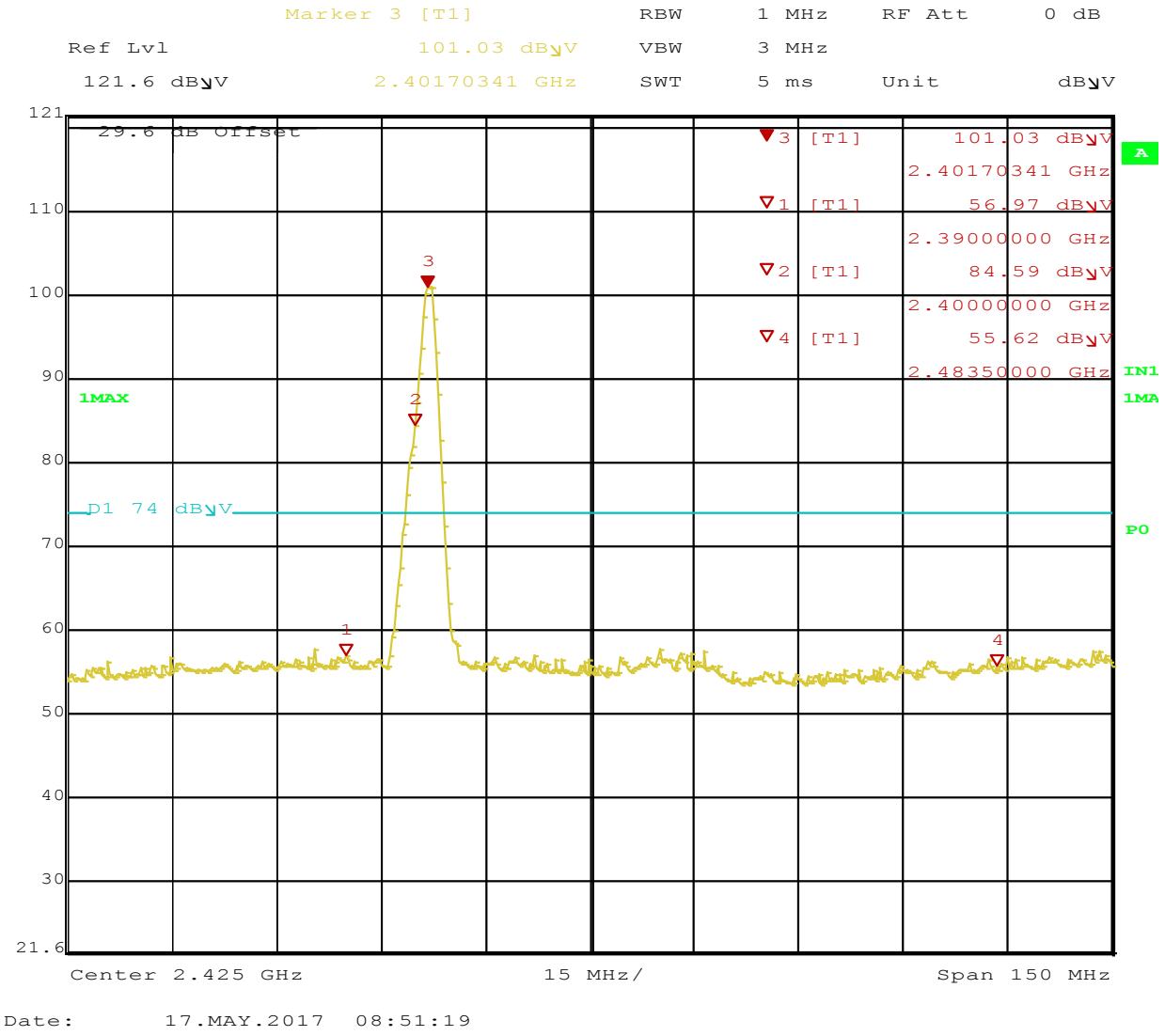


Figure 21: Radiated Emission at the Edge for Channel 2402 MHz at DH5 – Vertical (Pk)

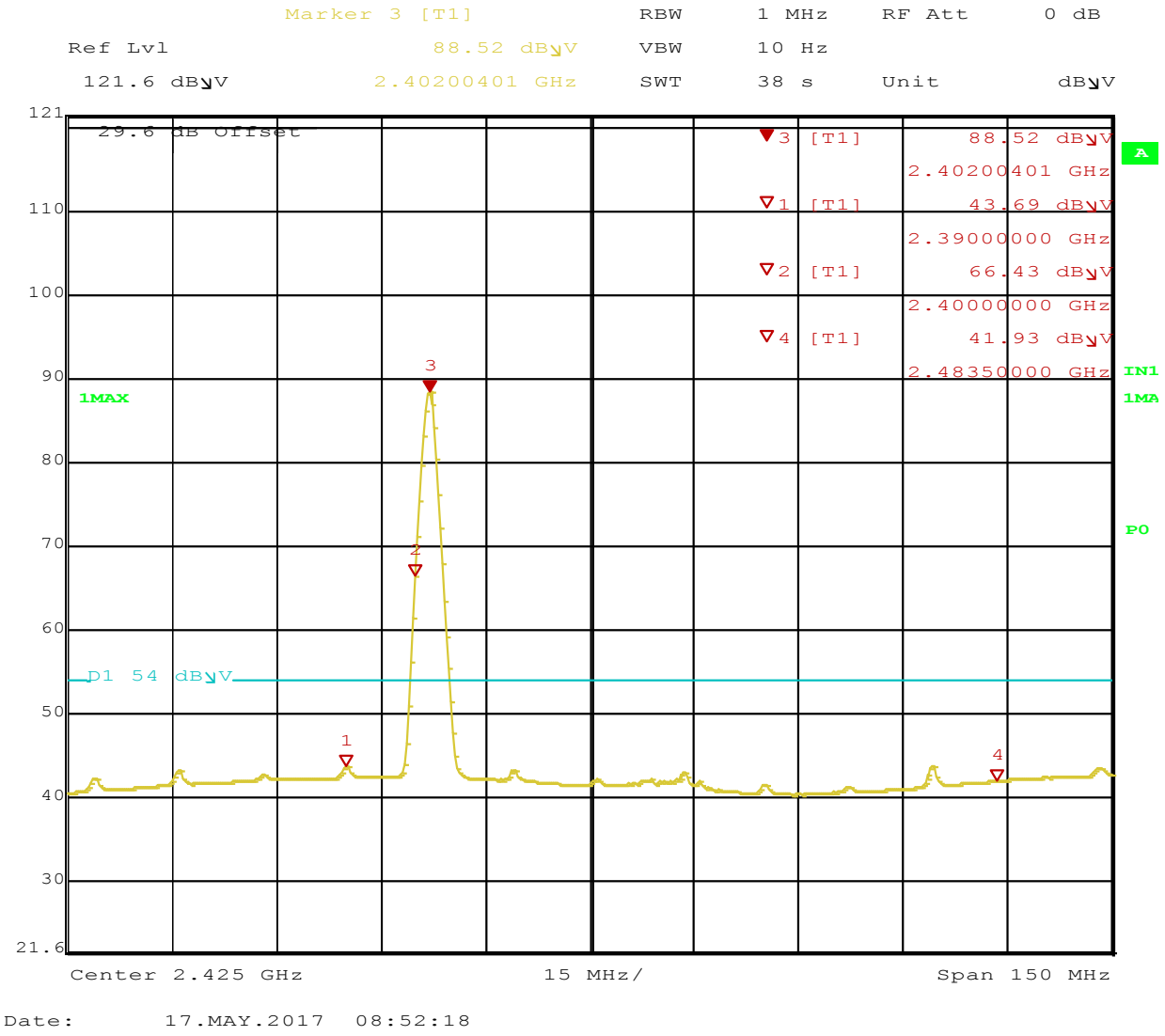


Figure 22: Radiated Emission at the Edge for Channel 2402 MHz at DH5 – Vertical (avg)

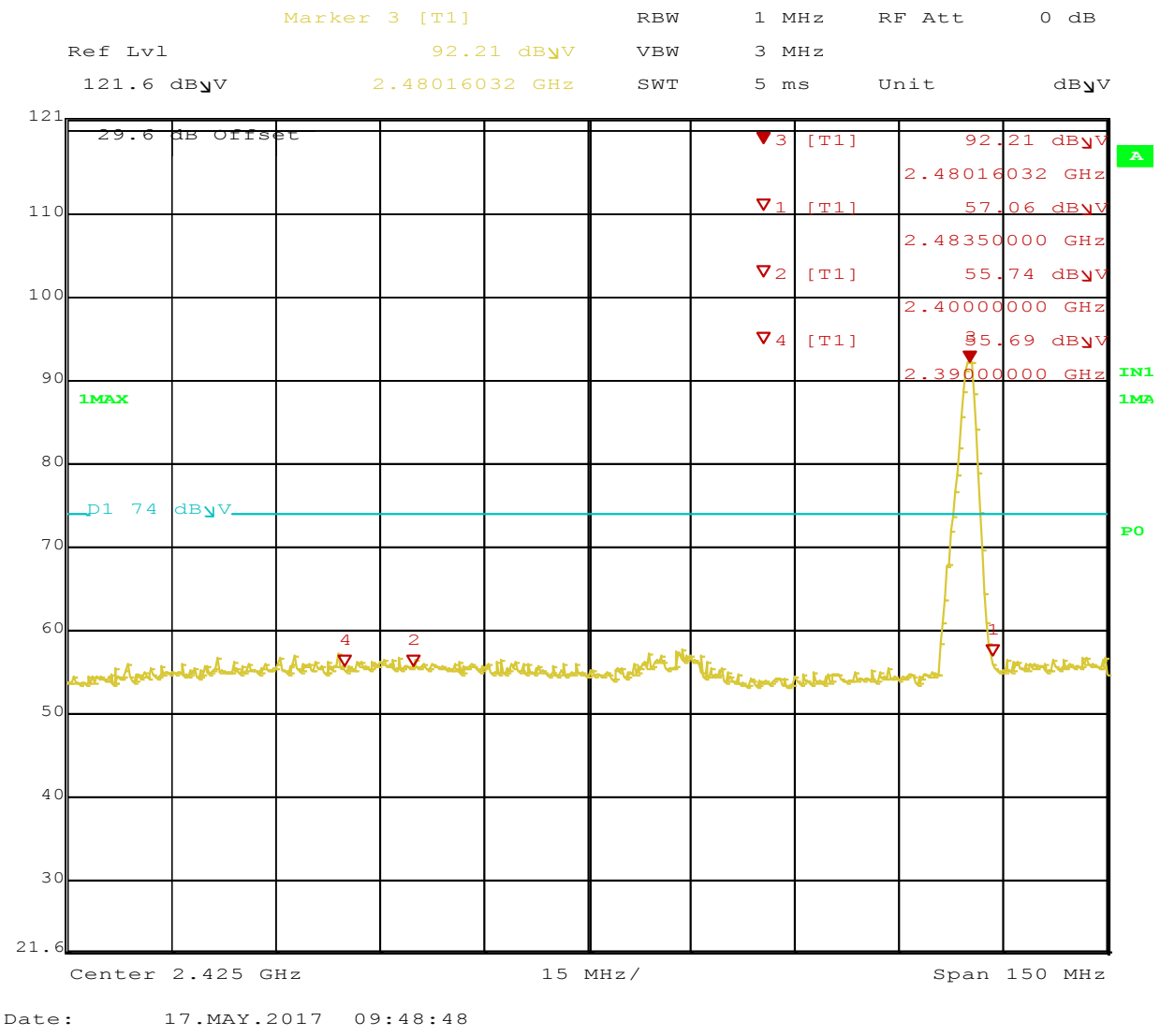


Figure 23: Radiated Emission at the Edge for Channel 2480 MHz at DH5 – Horizontal (Pk)

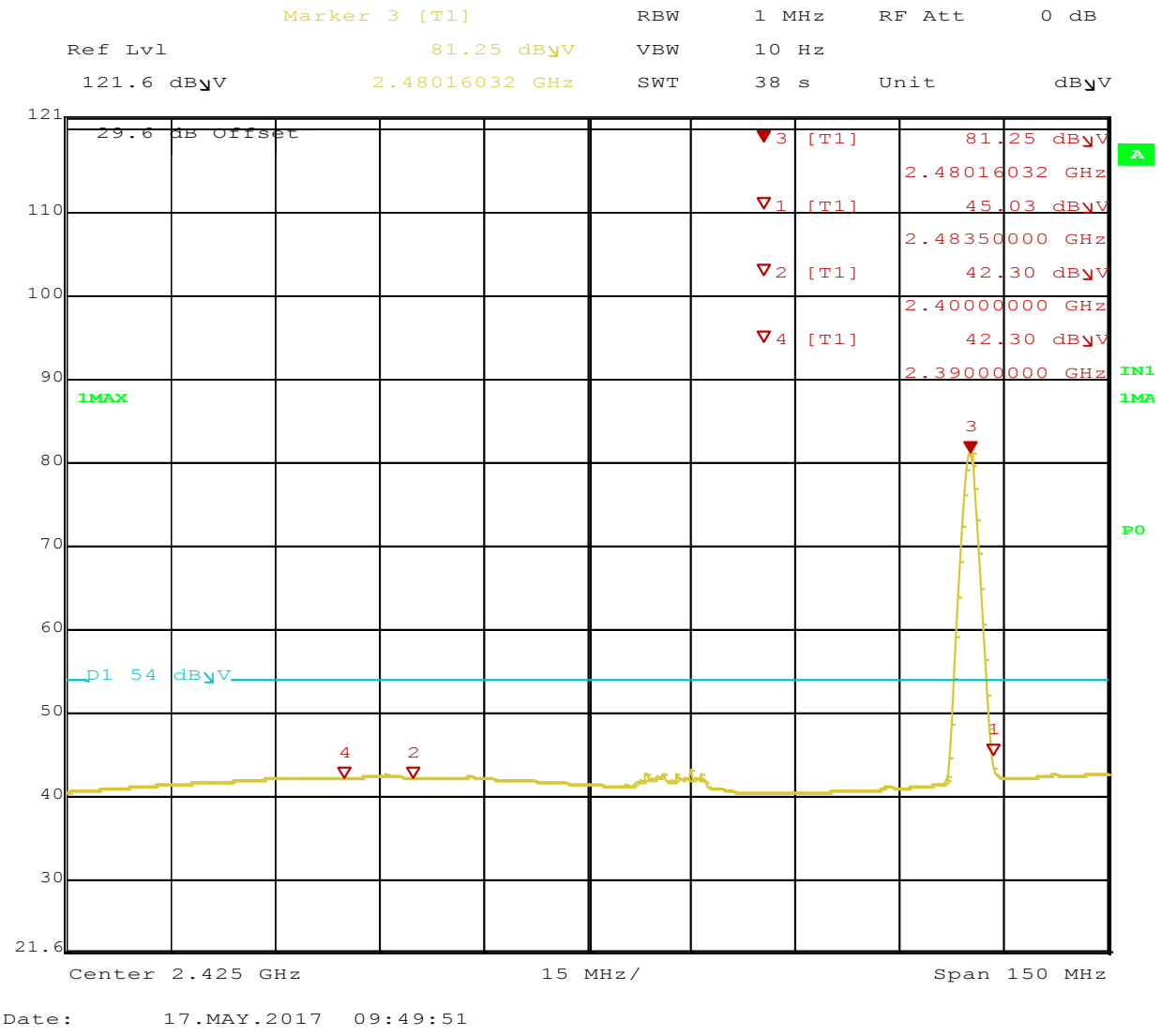


Figure 24: Radiated Emission at the Edge for Channel 2480 MHz at DH5 – Horizontal (Avg)

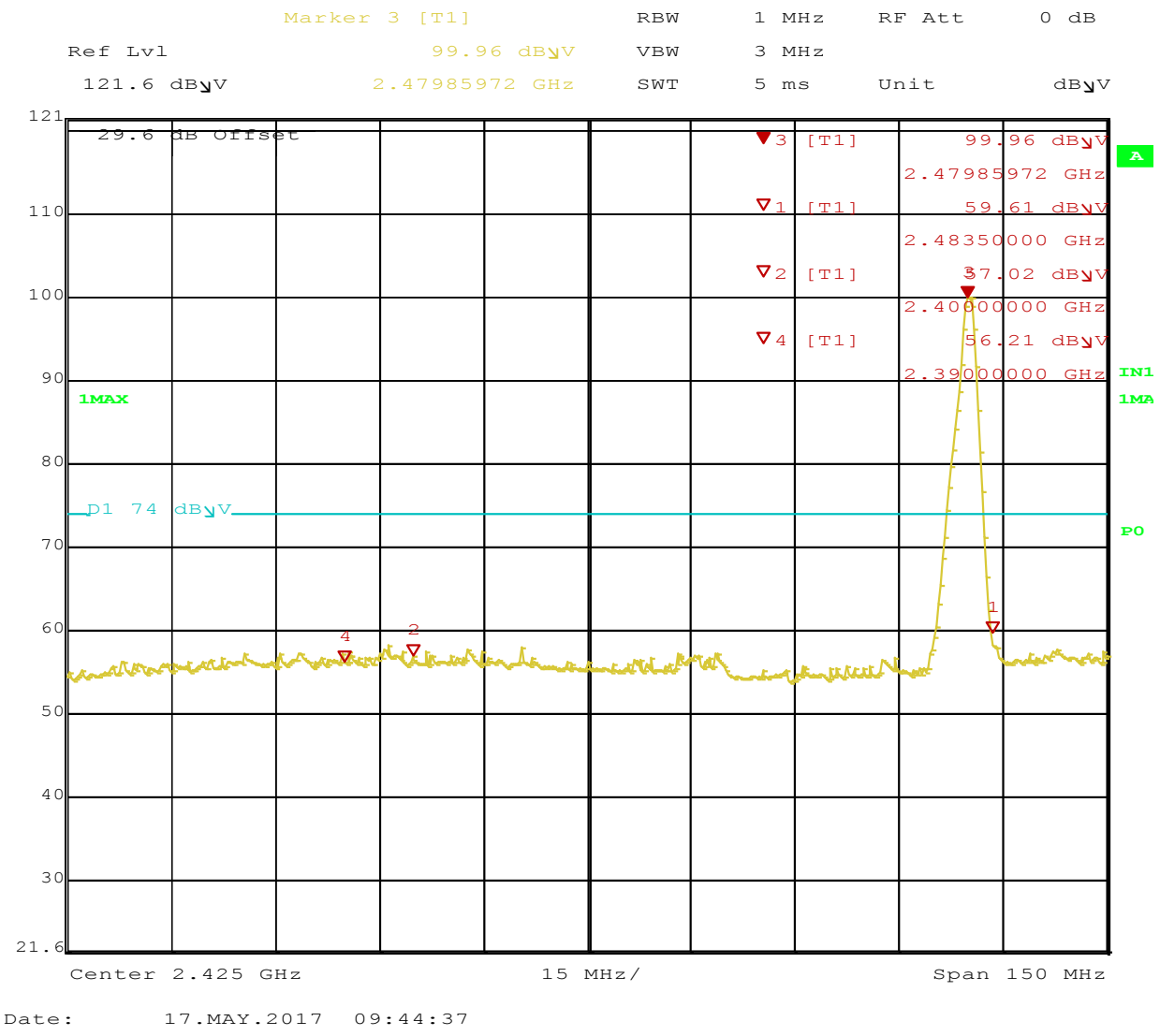


Figure 25: Radiated Emission at the Edge for Channel 2480 MHz at DH5 – Vertical (Pk)

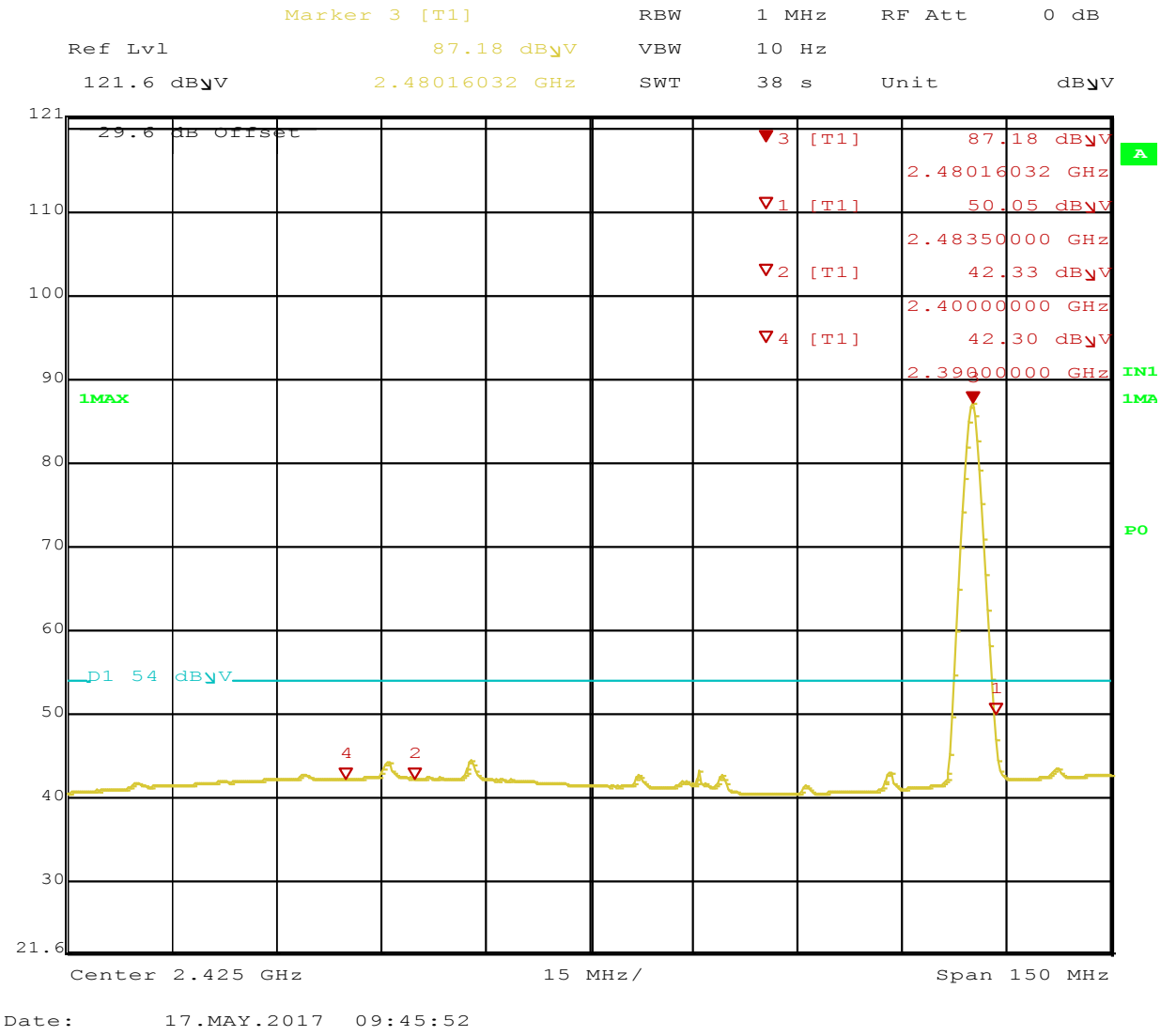


Figure 26: Radiated Emission at the Edge for Channel 2480 MHz at DH5 – Vertical (Avg)

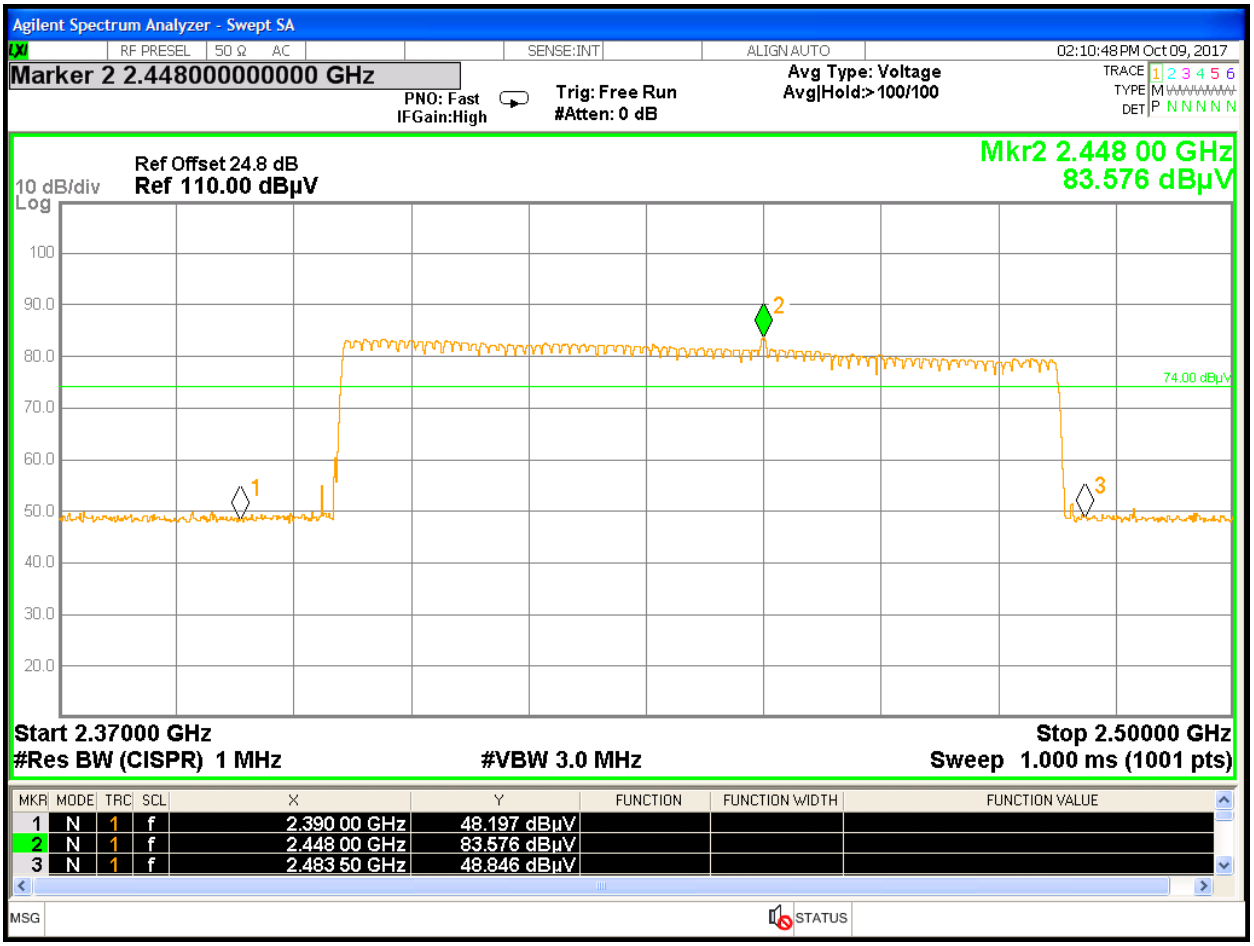


Figure 27: Radiated Emission at the Restricted Band Edge for Hopping Mode at DH5 – Horz. (Pk)

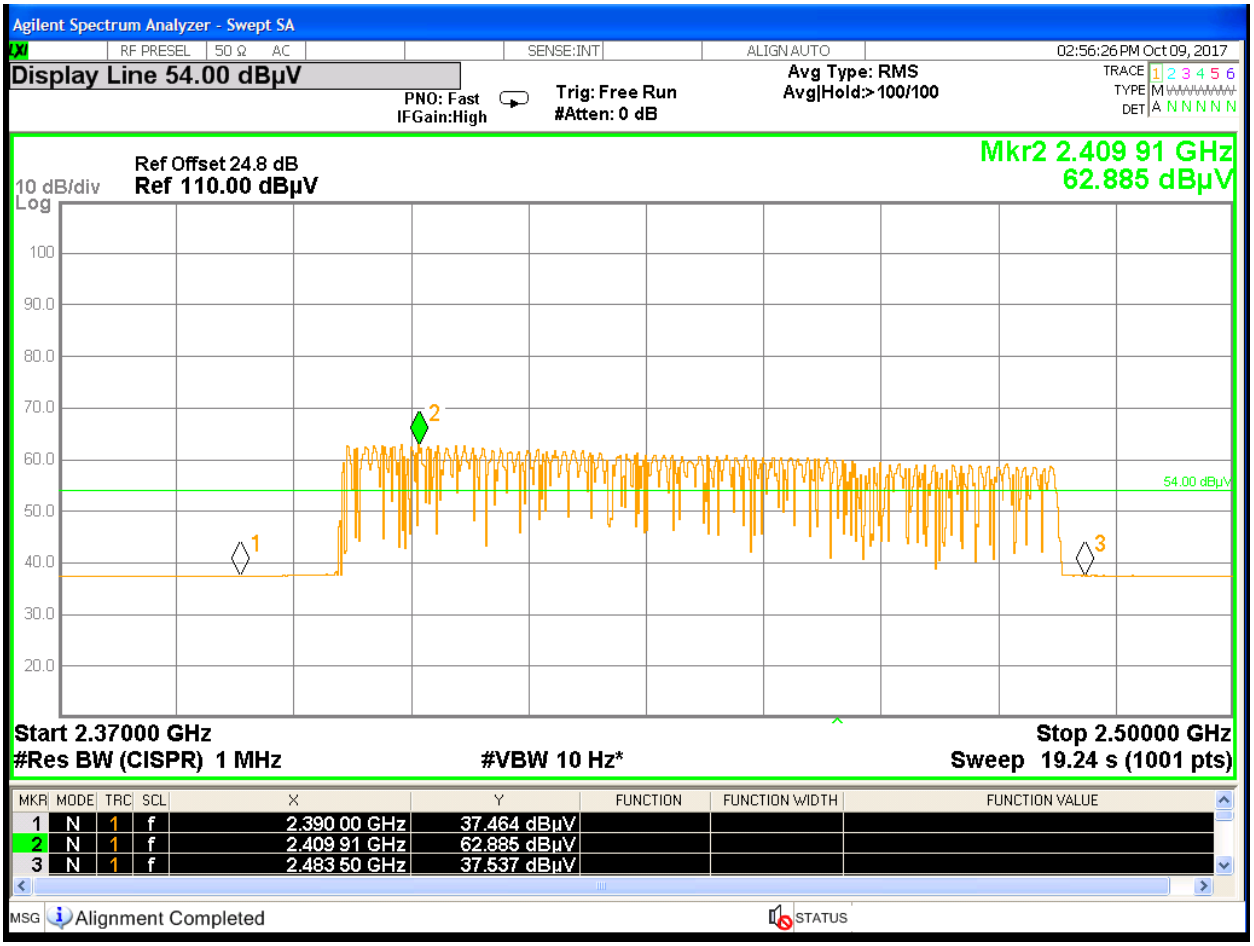


Figure 28: Radiated Emission at the Restricted Band Edge for Hopping Mode at DH5 – Horz. (Ave)

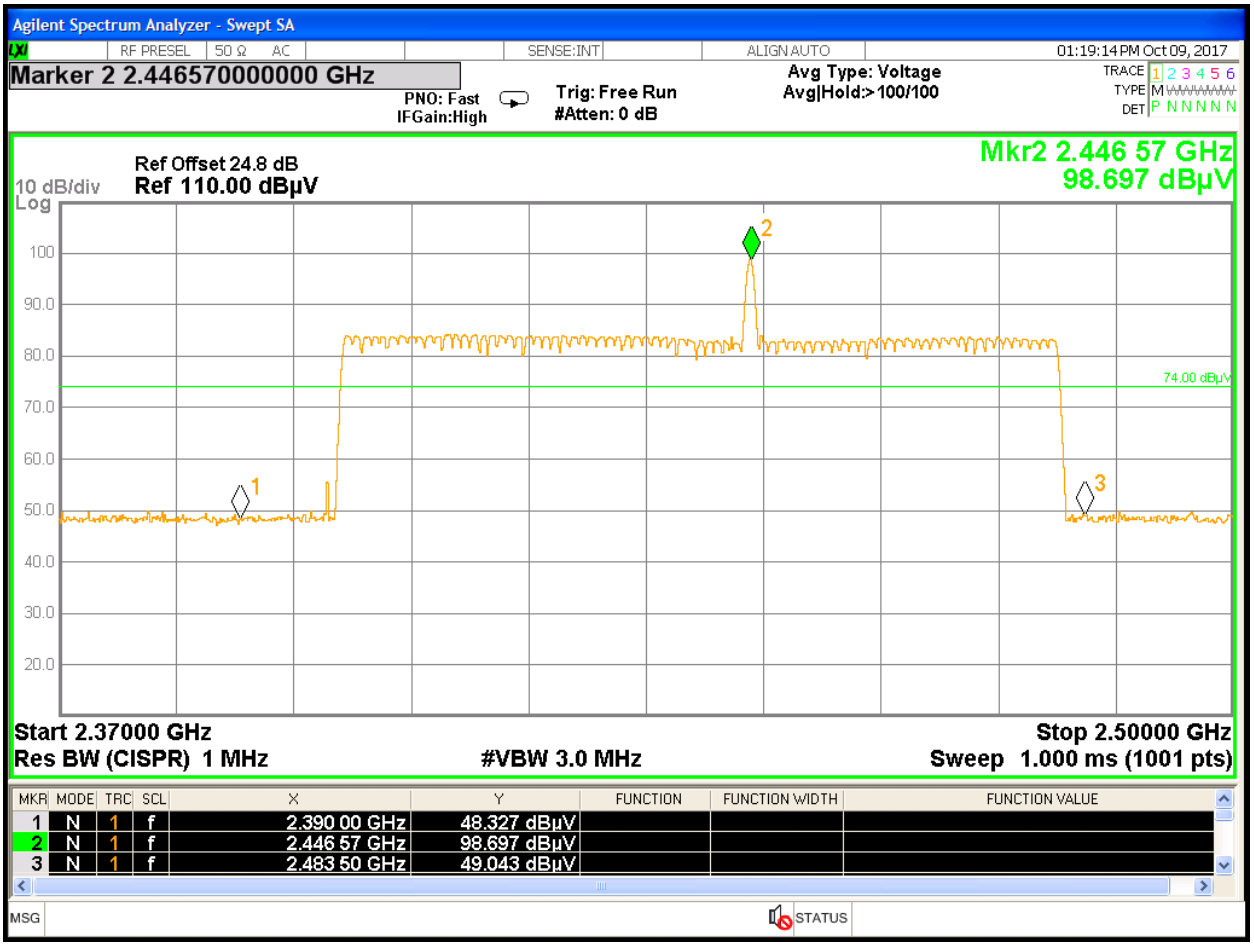


Figure 29: Radiated Emission at the Restricted Band Edge for Hopping Mode at DH5 – Vert. (Pk)

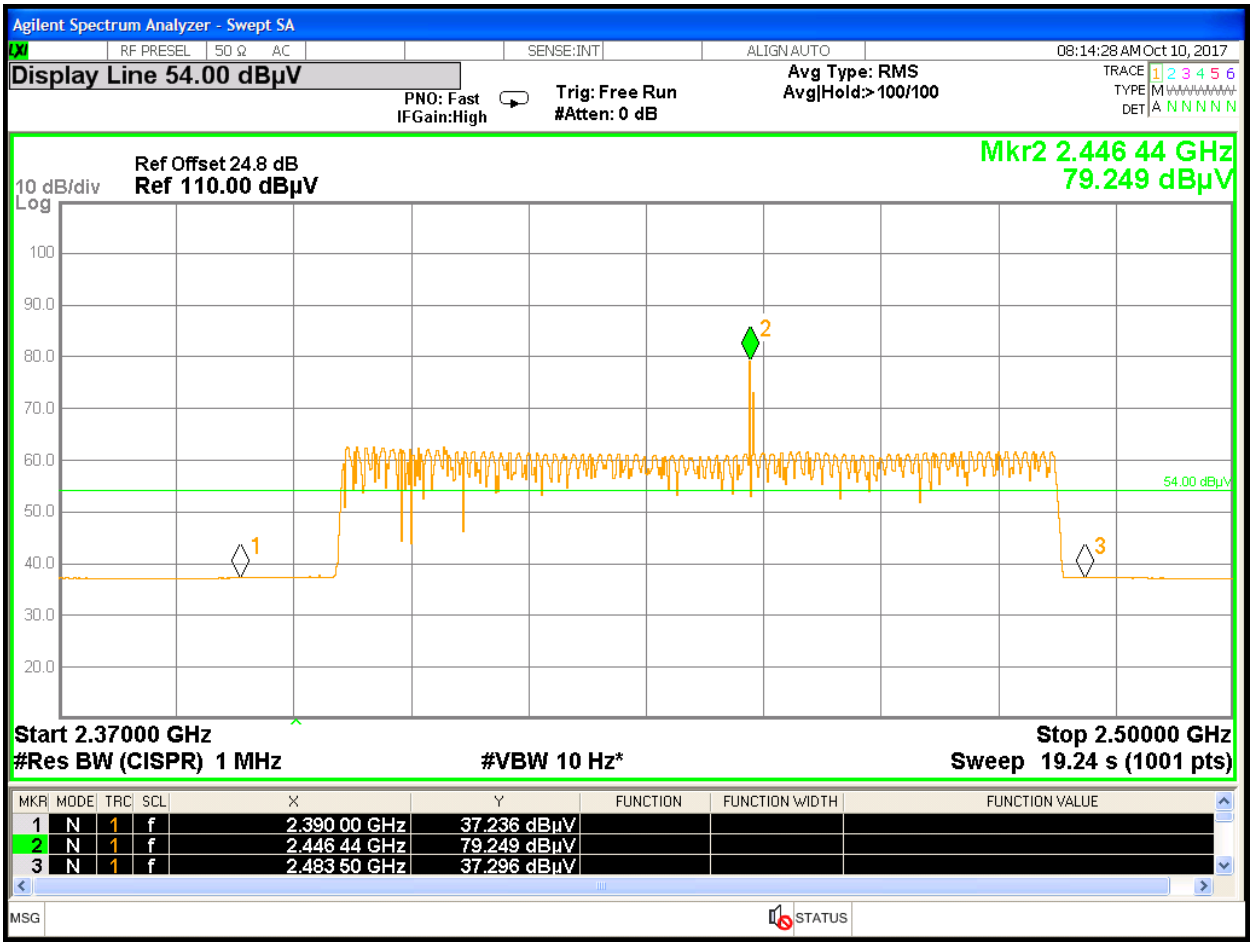


Figure 30: Radiated Emission at the Restricted Band Edge for Hopping Mode at DH5 – Vert. (Ave)

SOP 1 Radiated Emissions

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EUT Name	Bluetooth Module for JADAK/PRI Equipment	**Date**	May 19, 2017
EUT Model	JADAK/PRI P/N 6XYZ-0003-01	**Temp / Hum in**	23°C / 33%rh
EUT Serial	W31300084	**Temp / Hum out**	N/A
EUT Comfit.	Swivel SMA Antenna on Z-Axis	**Line AC / Freq**	5.0 V
Standard	CFR47 Part 15 Subpart C	**RBW / VBW**	120KHz/300KHz
Dist/Ant Used	3m /JB3	**Performed by**	Jeremy Luong

30 -1000 MHz radiated emission at 2441 MHz

Freq	Raw	Cable	AF	Level	Detector	Pol	Hgt	Azt	Limit	Margin	Result
MHz	dBuV/m	dB	dB	dBuV/m	Peak	-	cm	Deg	dBuV	dB	
792.00	36.90	5.31	-5.97	36.23	QP	H	109	168	46.00	-9.77	Pass
816.00	37.87	5.32	-5.56	37.64	QP	H	101	59	46.00	-8.36	Pass
840.01	37.39	5.40	-5.47	37.33	QP	H	109	62	46.00	-8.68	Pass
48.02	50.87	2.72	-18.94	34.65	QP	V	143	326	40.00	-5.35	Pass
72.02	51.92	2.89	-20.11	34.70	QP	V	138	22	40.00	-5.30	Pass
120.00	47.60	3.20	-14.50	36.30	QP	V	127	210	43.50	-7.20	Pass

Spec Margin = Level – Limit, Level = Raw + Cable + AF ± Uncertainty
AF= Amp Gain + ANT Factor

Combined Standard Uncertainty $u_c(y)$ = ± 4.52 dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

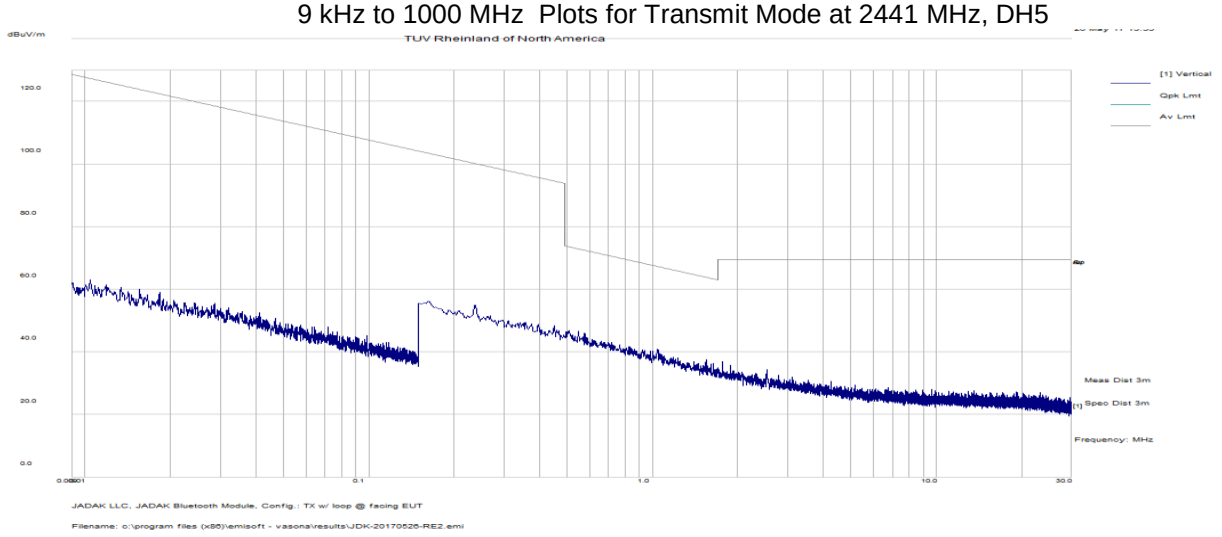
Notes: The worst case was observed on 2441MHz on DH5.
No significant emission observed below 30MHz; EUT does not have/ transmit magnetic field.

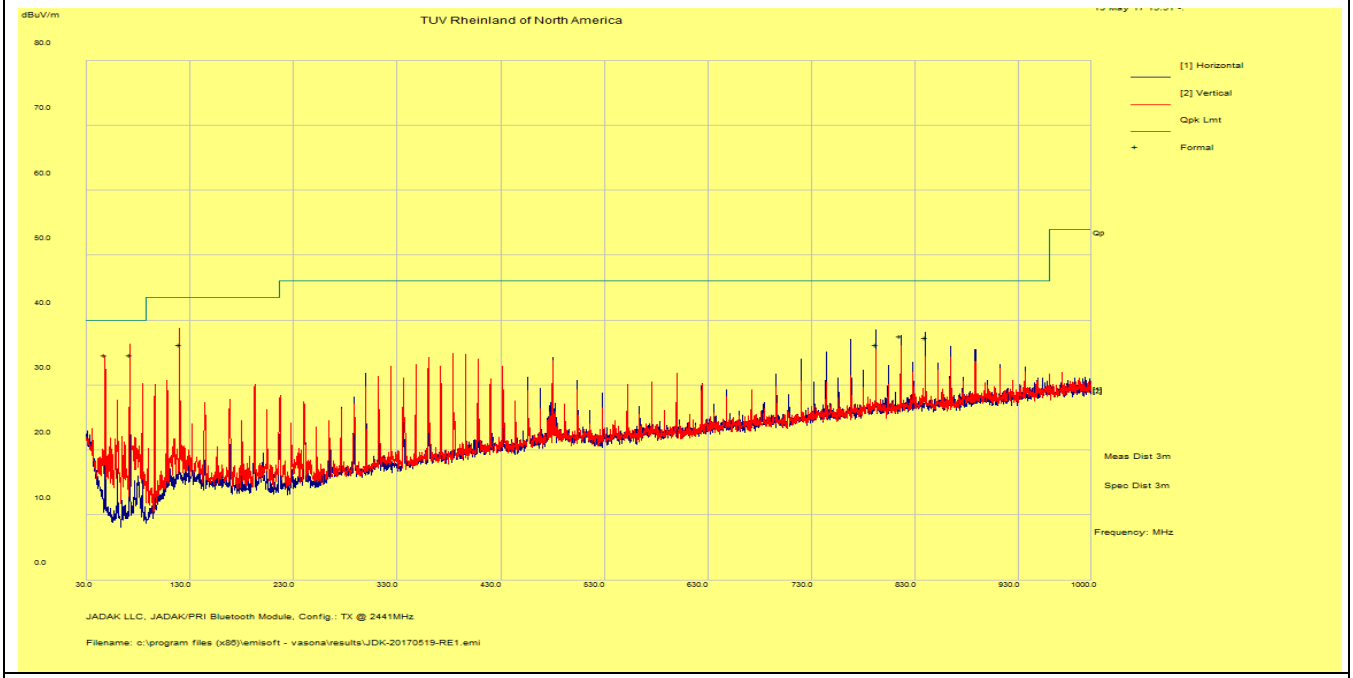
SOP 1 Radiated Emissions

Tracking # 31761453.001 Page 2 of 6

EUT Name	Bluetooth Module for JADAK/PRI Equipment	**Date**	May 19, 2017
EUT Model	JADAK/PRI P/N 6XYZ-0003-01	**Temp / Hum in**	23°C / 33%rh
EUT Serial	W31300084	**Temp / Hum out**	N/A
EUT Comfit.	Swivel SMA Antenna on Z-Axis	**Line AC / Freq**	5.0 V
Standard	CFR47 Part 15 Subpart C	**RBW / VBW**	120KHz/300KHz
Dist/Ant Used	3m /JB3	**Performed by**	Jeremy Luong

9 kHz to 1000 MHz Plots for Transmit Mode at 2441 MHz, DH5





Note: Plot was scanned in the peak mode.

SOP 1 Radiated Emissions

Tracking # 31761453.001 Page 3 of 6

EUT Name	Bluetooth Module for JADAK/PRI Equipment	**Date**	May 17, 2017
EUT Model	JADAK/PRI P/N 6XYZ-0003-01	**Temp / Hum in**	23°C / 32%rh
EUT Serial	W31300084	**Temp / Hum out**	N/A
EUT Comfit.	Swivel SMA Antenna on Z-Axis	**Line AC / Freq**	5.0 V
Standard	CFR47 Part 15 Subpart C	**RBW / VBW**	1MHz/3MHz
Dist/Ant Used	3m – DRH-118 / 1m - RA42-K-F-4B-C	**Performed by**	Jeremy Luong

Freq.	Raw	Cbl	AF	Level	Det.	Pol.	Hght.	Azt	Limit	Margin	Result
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB	
Above 1GHz Radiated Emission at 2402 MHz, DH5											
9608.29	46.53	2.55	-13.39	35.68	Ave	H	203	48	54.00	-18.32	Pass
17930.02	39.80	3.73	-3.21	40.32	Ave	H	150	4	54.00	-13.68	Pass
1802.05	60.68	1.03	-26.19	35.53	Ave	V	154	212	54.00	-18.47	Pass
4803.97	66.82	1.75	-20.11	48.46	Ave	V	244	36	54.00	-5.54	Pass
7206.52	65.80	2.20	-16.50	51.50	Ave	V	120	20	54.00	-2.50	Pass
19215.79	35.15	7.12	-5.58	36.68	Ave	H	125	14	54.00	-17.32	Pass
9608.29	46.53	2.55	-13.39	35.68	Ave	H	203	48	54.00	-18.32	Pass
Above 1GHz Radiated Emission at 2441 MHz, DH5											
7322.27	63.50	2.20	-15.60	50.10	Ave	H	222	40	54.00	-3.90	Pass
9763.93	50.52	2.58	-13.32	39.78	Ave	H	121	23	54.00	-14.22	Pass
17879.63	40.68	3.71	-3.48	40.91	Ave	H	140	67	54.00	-13.09	Pass
4882.07	65.71	1.77	-20.14	47.34	Ave	V	238	44	54.00	-6.66	Pass
19528.08	37.19	7.14	-5.68	38.65	Ave	H	129	30	54.00	-15.35	Pass
Above 1GHz Radiated Emission at 2480 MHz, DH5											
9920.12	50.62	2.61	-12.82	40.40	Ave	H	188	20	54.00	-13.60	Pass
2167.75	54.26	1.13	-25.30	30.09	Ave	V	138	252	54.00	-23.91	Pass
4960.07	63.79	1.79	-20.16	45.42	Ave	V	250	22	54.00	-8.59	Pass
7439.59	66.00	2.20	-15.60	52.60	Ave	V	109	14	54.00	-1.40	Pass
17904.52	40.53	3.72	-3.34	40.91	Ave	V	172	210	54.00	-13.09	Pass
19840.05	41.60	7.21	-5.73	43.08	Ave	H	128	78	54.00	-10.93	Pass

Spec Margin = Level – Limit, Level = Raw + Cable + AF ± Uncertainty
AF= Amp Gain + ANT Factor

Combined Standard Uncertainty $u_c(y)$ = ± 4.52 dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes: Worst case was observed in the DH5. All emissions met restricted band limit.

SOP 1 Radiated Emissions

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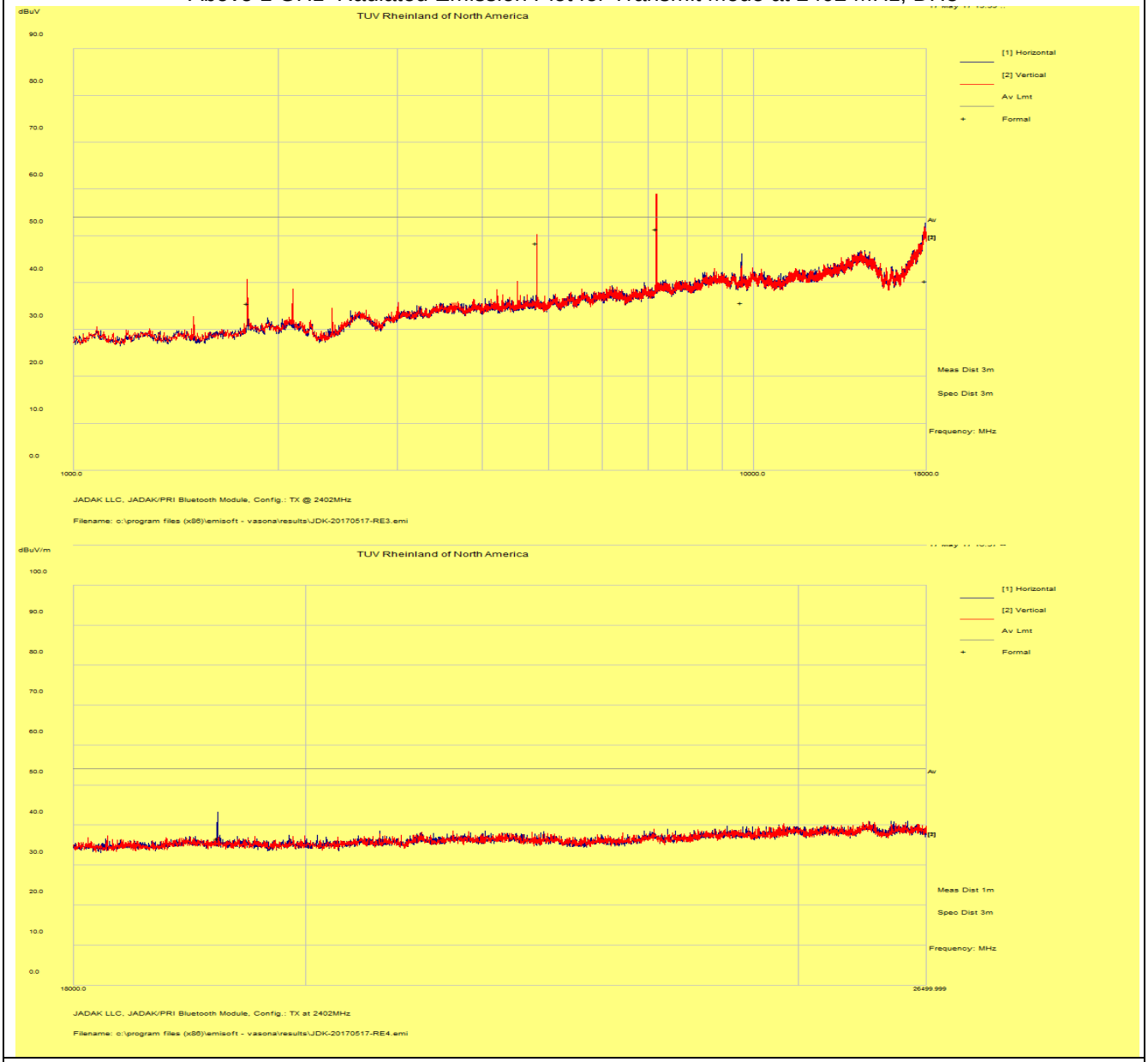
EUT Name	Bluetooth Module for JADAK/PRI Equipment	**Date**	May 17, 2017
EUT Model	JADAK/PRI P/N 6XYZ-0003-01	**Temp / Hum in**	23°C / 32%rh
EUT Serial	W31300084	**Temp / Hum out**	N/A
EUT Config.	Swivel SMA Antenna on Z-Axis	**Line AC**	5.0 V
Standard	CFR47 Part 15 Subpart C	**RBW / VBW**	1MHz/3MHz
Dist/Ant Used	3m – DRH-118 / 1m - RA42-K-F-4B-C	**Performed by**	Jeremy Luong

Above 1 GHz Radiated Emission Plot for Transmit Mode at 2402 MHz, DH5



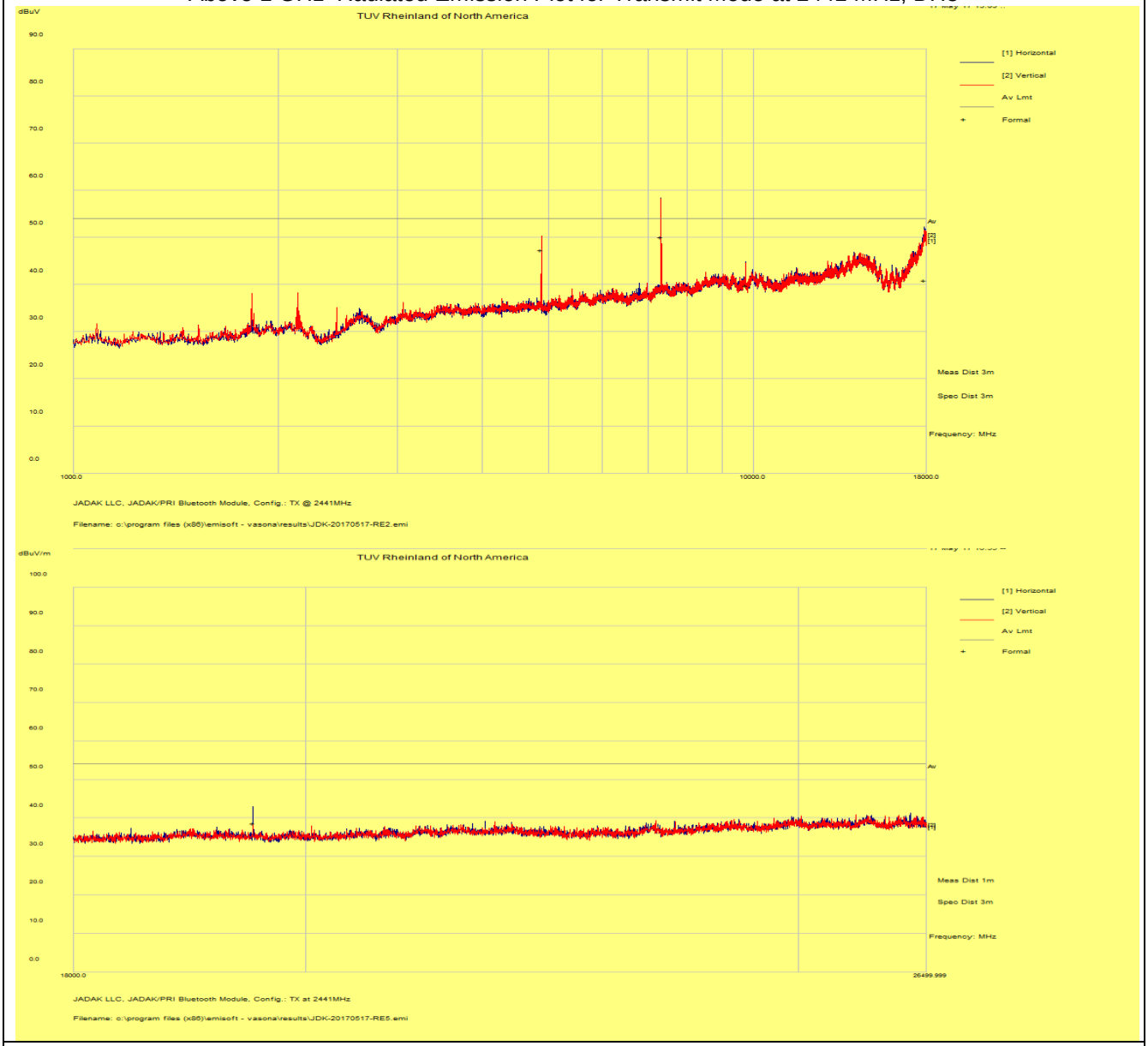
Notes: 18 GHz – 25 GHz was scanned at 1m distance.

SOP 1 Radiated Emissions

Tracking # 31761453.001 Page 5 of 6

EUT Name	Bluetooth Module for JADAK/PRI Equipment	**Date**	May 17, 2017
EUT Model	JADAK/PRI P/N 6XYZ-0003-01	**Temp / Hum in**	23°C / 32%rh
EUT Serial	W31300084	**Temp / Hum out**	N/A
EUT Config.	Swivel SMA Antenna on Z-Axis	**Line AC**	5.0 V
Standard	CFR47 Part 15 Subpart C	**RBW / VBW**	1MHz/3MHz
Dist/Ant Used	3m – DRH-118 / 1m - RA42-K-F-4B-C	**Performed by**	Jeremy Luong

Above 1 GHz Radiated Emission Plot for Transmit Mode at 2441 MHz, DH5



Notes: 18 GHz – 25 GHz was scanned at 1m distance.

4.5.2 Radiated Emissions Hopping Mode at DH5 with Host Device

4.5.2.1 §15.103 Exempted devices.

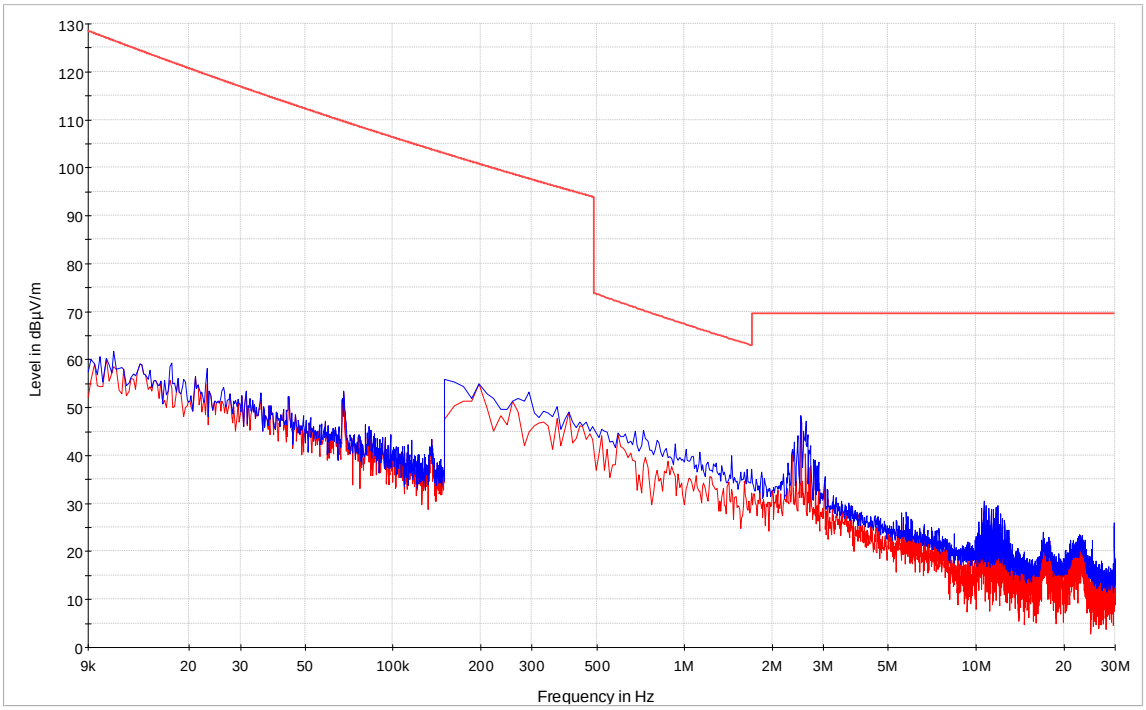
The following devices are subject only to the general conditions of operation in §§15.5 and 15.29 and are exempt from the specific technical standards and other requirements contained in this part. The operator of the exempted device shall be required to stop operating the device upon a finding by the Commission or its representative that the device is causing harmful interference. Operation shall not resume until the condition causing the harmful interference has been corrected. Although not mandatory, it is strongly recommended that the manufacturer of an exempted device endeavor to have the device meet the specific technical standards in this part.

**(c) A digital device used exclusively as industrial, commercial, or medical test equipment.

Frequency MHz	QuasiPeak dBµV/m	Height cm	Polarization	Azimuth deg	Corr. dB	Limit dBµV/m
124.4	50.1	100.0	V	-1.0	-4.9	43.5
124.4	52.0	400.0	H	-1.0	-4.9	43.5
**Radiated Emissions Hopping Mode at DH5 with Host Device 30MHz - 1000MHz						

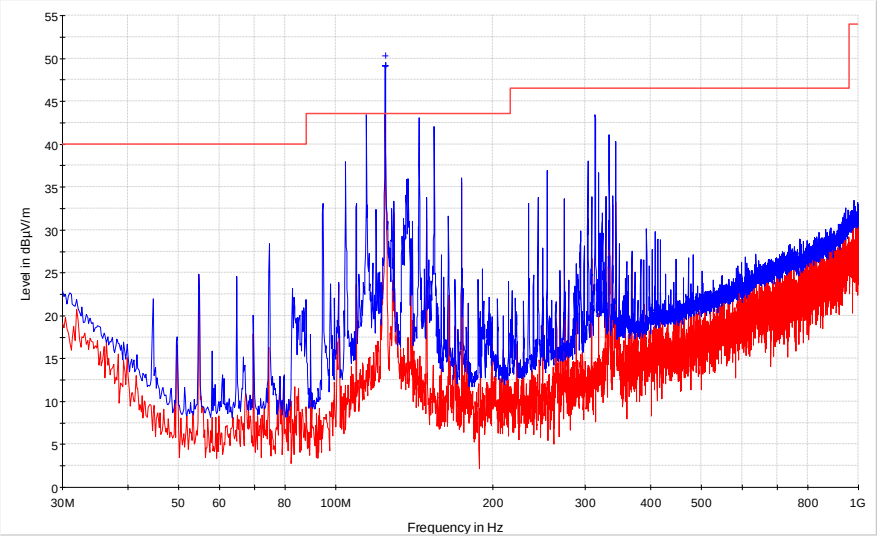
Frequency MHz	Caverage dBµV/m	Height cm	Polarization	Azimuth deg	Corr. dB	Limit dBµV/m	Margin dB
18000.0	35.9	150.0	V	2.0	16.1	54.0	-18.1
16306.8	33.5	170.0	V	317.0	14.3	54.0	-20.5
16351.0	34.0	150.0	V	171.0	14.3	54.0	-20.0
16735.3	34.7	150.0	V	154.0	15.2	54.0	-19.3
4935.5	25.8	170.0	H	345.0	2.8	54.0	-28.2
16303.5	33.3	160.0	H	345.0	14.3	54.0	-20.7
18000.0	35.6	150.0	H	352.0	16.1	54.0	-18.4
20001.8	35.8	200.0	V	2.0	20.1	54.0	-18.2
25083.0	36.2	250.0	H	340.0	20.4	54.0	-17.8
Radiated Emissions Hopping Mode at DH5 with Host Device 1GHz – 26.5GHz							

Radiated Emissions Hopping Mode at DH5 with Host Device 9kHz - 30MHz

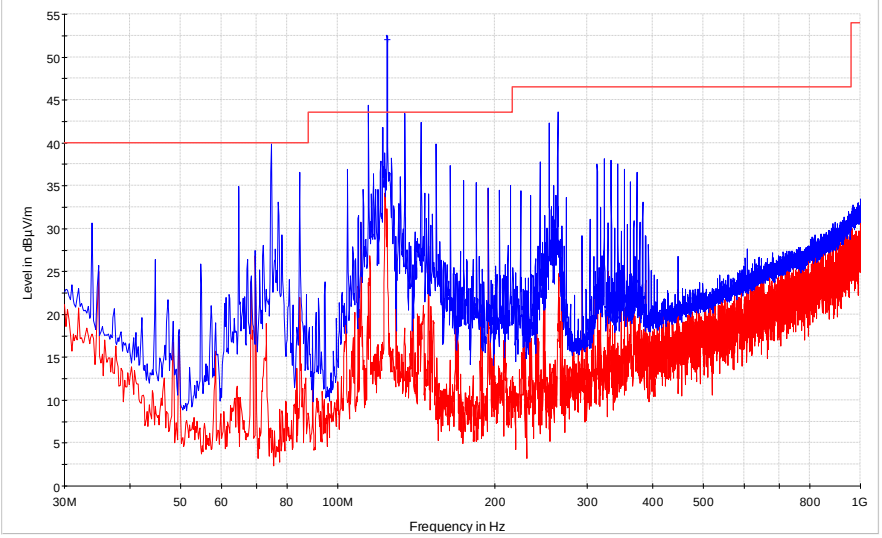


There were no measurable points in this spectrum.

****Radiated Emissions Hopping Mode at DH5 with Host Device 30MHz – 1GHz**



Vertical

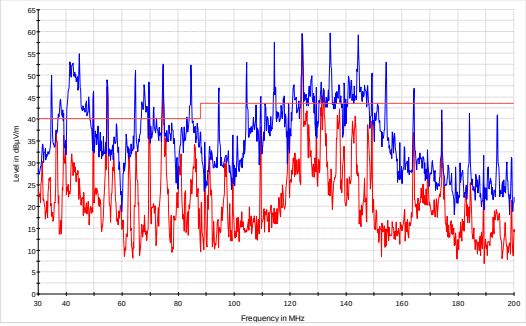


Horizontal

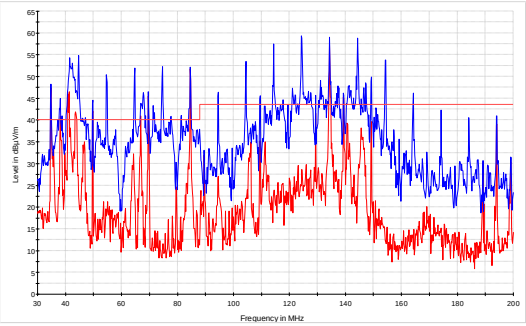
These scans show the Bluetooth module off and having no effect on the 124MHz signal.

**Radiated Emissions Hopping Mode at DH5 with Host Device 30MHz – 200MHz

Bluetooth on

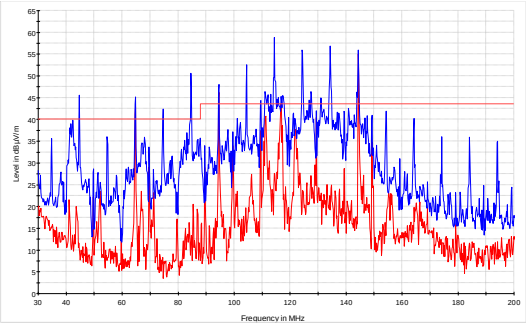


Bluetooth off

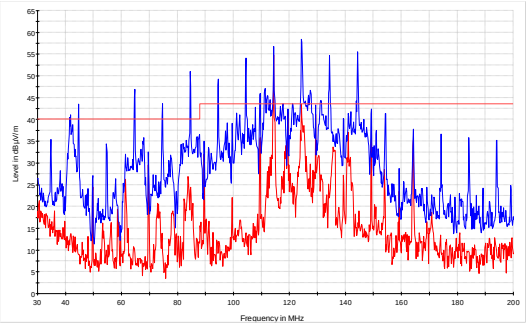


Vertical

Bluetooth on



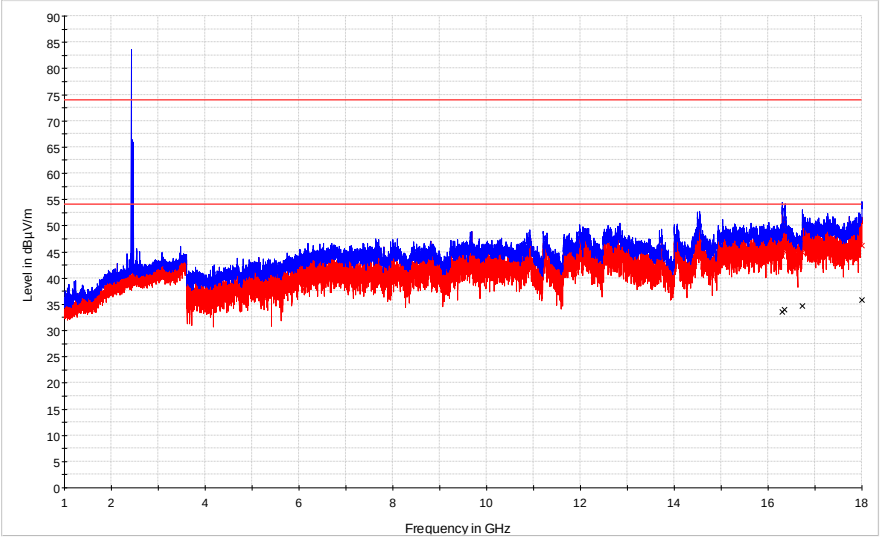
Bluetooth off



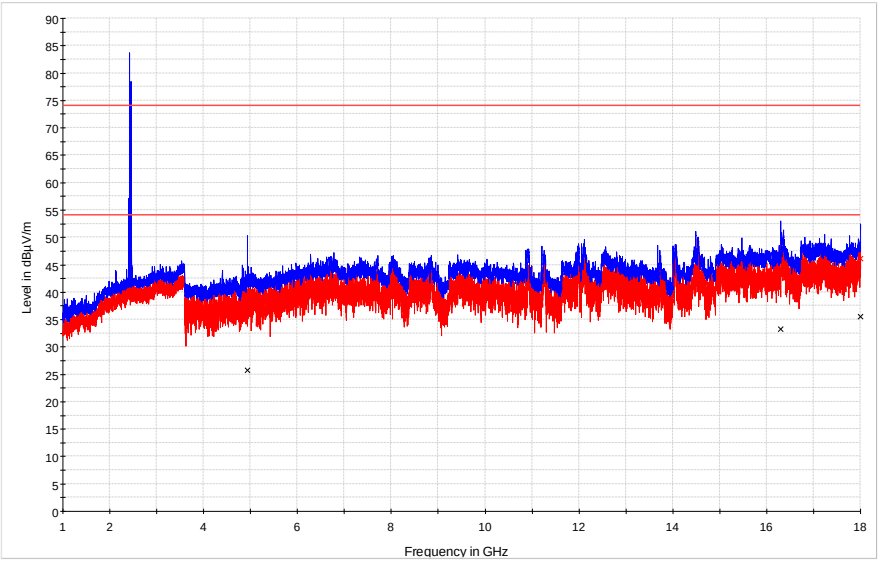
Horizontal

These traces show 30MHz to 200MHz with Bluetooth on and with Bluetooth off proving that the Bluetooth module does not impact the radiated emission profile.

Radiated Emissions Hopping Mode at DH5 with Host Device 1GHz - 18GHz

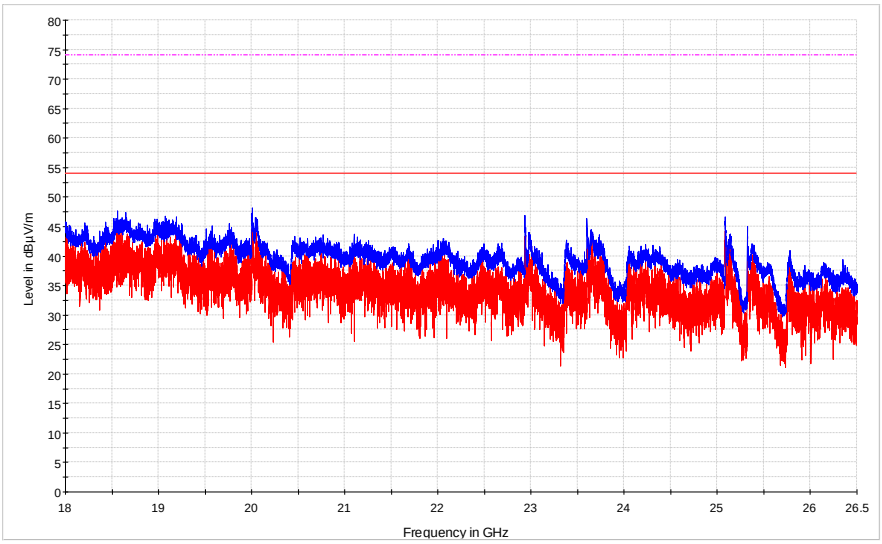


Vertical

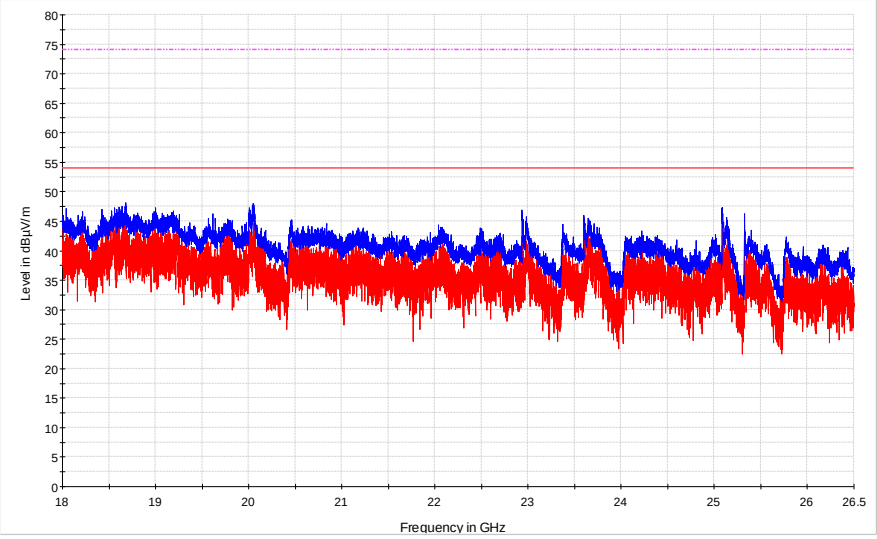


Horizontal

Radiated Emissions Hopping Mode at DH5 with Host Device 18GHz – 26.5GHz



Vertical



Horizontal

4.6 Sample Calculation

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

Field Strength (dBμV/m) = FIM - AMP + CBL + ACF

Where:

FIM = Field Intensity Meter (dBμV)
AMP = Amplifier Gain (dB)
CBL = Cable Loss (dB)
ACF = Antenna Correction Factor (dB/m)

$$\mu V/m = 10^{\frac{dB\mu V/m}{20}}$$

4.7 AC Conducted Emissions

Testing was performed in accordance with ANSI C63.10: 2013 Sect. 6.2. These test methods are listed under the laboratory's A2LA Scope of Accreditation.

This test measures the levels emanating from the EUT's AC input port, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices.

The AC conducted emissions of equipment under test shall not exceed the values in CFR47 Part 15.207: 2017 and RSS-Gen: 2014.

4.7.1 Test Methodology

A test program that controls instrumentation and data logging was used to automate the AC Power Line Conducted emission test procedure. The frequency range of interest was divided into sub-ranges such as to yield a frequency resolution of 9 kHz. Each phase and neutral of the AC power line were measured with respect to ground. Measurements were performed using a set of 50μH / 50Ω LISNs.

Testing is either performed in Lab 5. The setup photographs clearly identify which site was used. The vertical ground plane used in the semi-anechoic chamber is a 2m x 2m solid aluminum frame and panel, and it is bonded to the horizontal ground plane.

In the case of tabletop equipment, the EUT is placed on a 1.0m x 1.5m non-conductive table 80cm above the ground plane and 40cm from a vertical ground reference plane. The rear of the EUT was positioned flush with the backside of the table and directly over the LISNs. The power and I/O cables were routed over the edge of the table and bundled approximately 40cm from the ground plane. Support equipment was powered from a separate LISN.

4.7.1.1 Deviations

There were no deviations from this test methodology.

4.7.2 Test Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 7: AC Conducted Emissions – Test Results

Test Conditions: Conducted /Normal Temperature	**Date:** November 7, 2017	
Antenna Type: Swivel SMA Antenna	**Power Setting:** Fixed.	
Max. Antenna Gain: +4.4 dBi	**Signal State:** Modulated in DH5.	
AC Power: 110 Vac/60 Hz	**Configuration:** Tabletop	
Ambient Temp.: 23º C	**Relative Humidity:** 31 %RH	
Configuration	**Frequency Range**	**Test Result**
Line 1 (Hot)	0.15 to 30 MHz	Pass
Line 2 (Neutral)	0.15 to 30 MHz	Pass
Notes: Performed at 2402MHz on DH5. It was observed as the worst case.		

SOP 2 Conducted Emissions

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EUT Name	Bluetooth Module for JADAK/PRI Equipment	**Date**	November 7, 2017
EUT Model	JADAK/PRI P/N 6XYZ-0003-01	**Temp / Hum in**	23° C / 31% rh
EUT Serial	W31300084	**Temp / Hum out**	N/A
EUT Config.	Module installed inside the host device	**Line AC / Freq**	110Vac/60Hz
Standard	CFR47 Part 15.207	**RBW / VBW**	9kHz / 30kHz
Lab/LISN	Lab 5 / L1-200	**Performed by**	Jeremy Luong

Frequency	Peak	QP	Avg	Line	QP Limit	Ave Limit	Margin (QP)	Margin (Ave)	Result
MHz	dBuV	dBuV	dBuV		dB	dB	dB	dB	
0.222	50.60	47.80	35.80	Live	62.80	52.70	-15.00	-16.90	Pass
0.436	46.90	45.00	39.80	Live	57.10	47.10	-12.10	-7.30	Pass
0.469	40.00	36.80	28.40	Live	56.50	46.50	-19.70	-18.10	Pass
0.795	40.10	38.20	31.60	Live	56.00	46.00	-17.80	-14.40	Pass
1.217	41.00	38.90	33.50	Live	56.00	46.00	-17.10	-12.50	Pass
1.678	42.90	40.70	35.80	Live	56.00	46.00	-15.30	-10.20	Pass
2.091	43.70	40.90	36.00	Live	56.00	46.00	-15.10	-10.00	Pass
3.694	40.60	37.50	32.00	Live	56.00	46.00	-18.50	-14.00	Pass
29.861	46.20	45.60	45.30	Live	60.00	50.00	-14.40	-4.70	Pass

Spec Margin = QP./Ave. - Limit, ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.2 dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

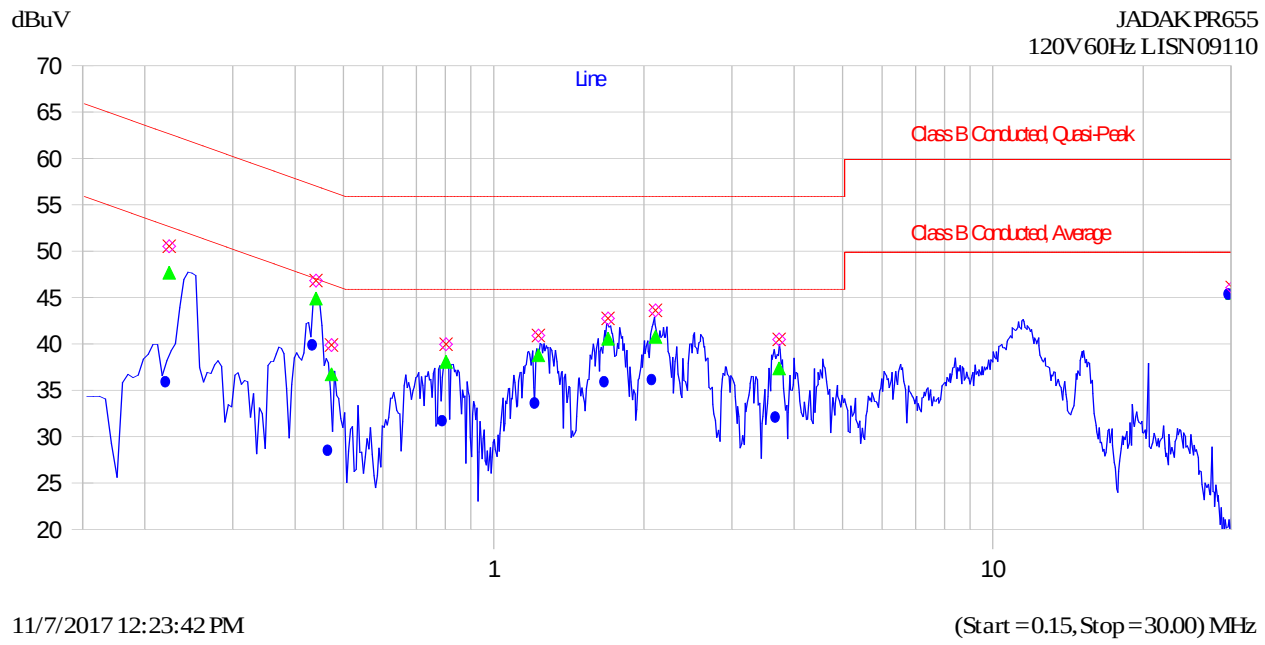
Notes: The JADAK/PRI Bluetooth Module is powered by a 5.0VDC from host device.

SOP 2 Conducted Emissions

Tracking # 31761453.001 Page 2 of 4

EUT Name	Bluetooth Module for JADAK/PRI Equipment	**Date**	November 7, 2017
EUT Model	JADAK/PRI P/N 6XYZ-0003-01	**Temp / Hum in**	23° C / 31% rh
EUT Serial	W31300084	**Temp / Hum out**	N/A
EUT Config.	Module installed inside the host device	**Line AC / Freq**	110Vac/60Hz
Standard	CFR47 Part 15.207	**RBW / VBW**	9kHz / 30kHz
Lab/LISN	Lab 5 / L1-200	**Performed by**	Jeremy Luong

150kHz to 30 MHz Plot for Line 1 (Hot)



Notes: Meet FCC Class B limit.

SOP 2 Conducted Emissions

Tracking # 31761453.001 Page 3 of 4

EUT Name	Bluetooth Module for JADAK/PRI Equipment	**Date**	November 7, 2017
EUT Model	JADAK/PRI P/N 6XYZ-0003-01	**Temp / Hum in**	23° C / 31% rh
EUT Serial	W31300084	**Temp / Hum out**	N/A
EUT Config.	Module installed inside the host device	**Line AC / Freq**	110Vac/60Hz
Standard	CFR47 Part 15.207	**RBW / VBW**	9kHz / 30kHz
Lab/LISN	Lab 5 / L1-200	**Performed by**	Jeremy Luong

Frequency	Peak	QP	Avg	Line	QP Limit	Ave Limit	Margin (QP)	Margin (Ave)	Result
MHz	dBuV	dBuV	dBuV		dB	dB	dB	dB	
0.156	55.00	53.00	39.50	Neutral	65.70	55.70	-12.70	-16.20	Pass
0.244	45.40	42.80	33.10	Neutral	62.00	52.00	-19.20	-18.90	Pass
0.434	47.30	45.80	40.10	Neutral	57.20	47.20	-11.40	-7.10	Pass
0.668	39.80	38.00	31.80	Neutral	56.00	46.00	-18.00	-14.20	Pass
1.234	39.60	37.70	32.40	Neutral	56.00	46.00	-18.30	-13.60	Pass
1.679	39.70	37.30	32.30	Neutral	56.00	46.00	-18.70	-13.70	Pass
15.315	40.30	37.10	31.70	Neutral	60.00	50.00	-22.90	-18.30	Pass
24.892	45.50	43.90	30.30	Neutral	60.00	50.00	-16.10	-19.70	Pass
29.861	46.40	45.60	45.20	Neutral	60.00	50.00	-14.40	-4.80	Pass

Spec Margin = QP./Ave. - Limit, ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.2 dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

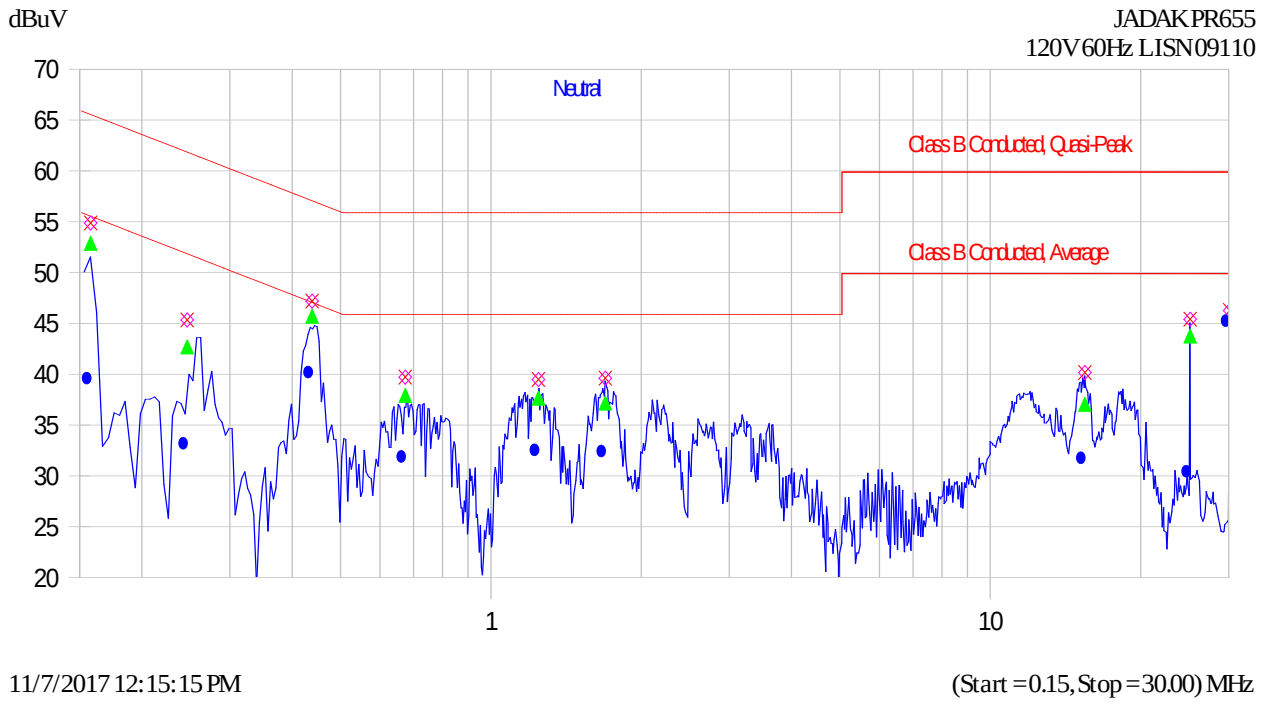
Notes: The JADAK/PRI Bluetooth Module is powered by a 5.0VDC from host device.

SOP 2 Conducted Emissions

Tracking # 31761453.001 Page 4 of 4

EUT Name	Bluetooth Module for JADAK/PRI Equipment	**Date**	November 7, 2017
EUT Model	JADAK/PRI P/N 6XYZ-0003-01	**Temp / Hum in**	23° C / 31% rh
EUT Serial	W31300084	**Temp / Hum out**	N/A
EUT Config.	Module installed inside the host device	**Line AC / Freq**	110Vac/60Hz
Standard	CFR47 Part 15.207	**RBW / VBW**	9kHz / 30kHz
Lab/LISN	Lab 5 / L1-200	**Performed by**	Jeremy Luong

150 kHz to 30 MHz Plot for Line 2 (Neutral)



Note: Meet FCC Class B Limit.

4.8 Maximum Permissible Exposure

4.8.1 Test Methodology

In this document, we try to prove the safety of radiation harmfulness to the human body for our product. The limit for Maximum Permissible Exposure (MPE) specified in FCC 1.1310 is followed. The Gain of the antenna used in this product is measured in a Semi-Anechoic Chamber, and also the maximum total power input to the antenna is measured. Through the Friis transmission formula and the maximum gain of the antenna, we can calculate the distance, away from the product, where the limit of MPE is reached.

Although the Friis transmission formula is a far field assumption, the calculated result of that is an over-prediction for near field power density. We will take that as the worst case to specify the safety range.

4.8.2 RF Exposure Limit

According to FCC 1.1310 table 1: The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b)

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (minutes)
(A)Limits For Occupational / Control Exposures				
0.3-1.34	614	1.63	*(100)	6
1.34-30	1842/f	4.89/f	*(900/f²)	6
30-300	61.4	0.163	1.0	6
30-1500	…	…	F/300	6
1500-100000	…	…	1.0	6
(B)Limits For General Population / Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f²)	30
30-300	27.5	0.073	0.2	30
30-1500	…	…	F(MHz)/1500MHz	30
1500-100000	…	…	1.0	30

F = Frequency in MHz

*=Plane wave equivalent density

According to RSS-102 Issue 5: The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation

RF FIELD STRENGTH LIMITS FOR DEVICES USED BY THE GENERAL PUBLIC (UNCONTROLLED ENVIRONMENT)

Frequency Range (MHz)	**Electric Field (V/m rms)**	**Magnetic Field (A/m rms)**	**Power Density (W/m^2)**	**Reference Period (minutes)**
0.003-10[21]	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	$58.07/f^{0.25}$	$0.1540/f^{0.25}$	$8.944/f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142f^{0.3417}$	$0.008335f^{0.3417}$	$0.02619f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

4.8.3 EUT Operating Condition

The software provided by Manufacturer enabled the EUT to transmit data at lowest, middle and highest channel individually.

4.8.4 Classification

The antenna of the product, under normal use condition, is at least 20cm away from the body of the user. Warning statement to the user for keeping at least 20cm or more separation distance with the antenna should be included in user's manual. So, this device is classified as a **Mobile Device**.

4.8.5 Test Results

4.8.5.1 Antenna Gain

The transmitting antenna was integrated. The maximum antenna gain for the highest observed power was +4.4 dBi or 2.75 (numeric).

4.8.5.2 Output Power into Antenna & RF Exposure value at distance 20cm:

Calculations for this report are based on highest power measurement.

Limit for MPE (from FCC part 1.1310 table1) is 1.0 mW/cm^2

The highest measured power is +4.73 dBm or 2.97 mW.

Corrected (including cal factors) Measurment:	2.97	mW	
The Gain of the antenna:	4.40	dBi	
Type of Measurment:	Conducted		Direct measurement at Antenna Port
Impedance:	50.00	Ω	
Measureing Distance:	0.00	m	
Time weighted Duty Cycle:	77.10	%	

The Power Out would be:	0.001765490	Watts
or:	1.76549	mW
or:	1765.49	µW
or:	2.47	dBm

Frequency range from 10 MHz to 40 GHz:

Frequency:	2.402	GHz

Power output with DC and antenna Gain (EiRP):

Power (dBm):	6.87
Power (mW):	4.863
Power (W):	0.004863

R = distance in	20	cm

FCC:		
Controlled Exposures - Limit =	5	mW/cm^2
Uncontrolled Exposures - Limit =	1	mW/cm^2
Pd =	0.0009674	mW/cm^2
Controlled Margin to Limit =	4.9990	mW/cm^2
Uncontrolled Margin to Limit =	0.9990	mW/cm^2

Note: * = Plane-wave equivalent power density

IC:		
Controlled Exposures to Limit =	31.63608605	W/m^2
Uncontrolled Exposures Limit =	5.350804563	W/m^2
Pd =	0.009674	W/m^2
Controlled Margin to Limit =	31.6264	W/m^2
Uncontrolled Margin to Limit =	5.3411	W/m^2

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

4.8.6 Sample Calculation

The Friss transmission formula: $Pd = (Pout*G) / (4*\pi*R^2)$

Where;

Pd = power density in mW/cm_2
Pout = output power to antenna in mW
G = gain of antenna in linear scale
$\pi \approx 3.1416$
R = distance between observation point and center of the radiator in cm

Ref. : David K. Cheng, *Field and Wave Electromagnetics*, Second Edition, Page 640, Eq. (11-133).

6 Test Equipment Use List

6.1 Equipment List

Equipment	Manufacturer	Model #	Serial/Inst #	Last Cal mm/dd/yyyy	Next Cal mm/dd/yyyy
Loop Antenna	EMCO	6502	62531	06/08/2016	06/08/2018
Bilog Antenna	Sunol Sciences	JB3	A102606	06/15/2016	06/15/2018
Horn Antenna	Sunol Sciences	3115	9211-3969	05/16/2017	05/16/2019
Antenna w/ Amplifier	Rohde & Schwarz	TS-PR26	100011	07/11/2017	07/11/2018
Spectrum Analyzer	Rohde & Schwarz	FSL6	100169	01/13/2017	01/13/2018
Spectrum Analyzer	Agilent	N9038A	MY552260210	01/16/2017	01/16/2018
Spectrum Analyzer	Rohde Schwarz	ESIB	832427/002	01/16/2017	01/16/2018
Spectrum Analyzer	Rohde Schwarz	FSV40	1321.3008K40	08/30/2016	08/30/2017
Amplifier	Sonoma Instruments	310	165516	01/19/2017	01/19/2018
Amplifier	Rohde & Schwarz	TS-PR18	3545-7008-03	01/19/2017	01/19/2018
Power Meter	Agilent	E4418B	MY45103902	01/11/2017	01/11/2018
Power Sensor	Hewlett Packard	8482A	1925A04647	01/01/2017	01/01/2018
Thermometer	Fluke	52II	88650033	11/04/2016	11/04/2017
Thermo Chamber	Espec	BTZ-133	0613436	NCR	NCR
DC Power Supply	Agilent	E3634A	MY400004331	01/12/2017	01/12/2018
Notch Filter	Micro-Tronics	BRM50702	37	07/29/2016	07/29/2017
Signal Generator	Anritsu	MG3694A	42803	01/13/2017	01/13/2018
Signal Generator	Rohde & Schwarz	SMF100A	1167.0000K02	09/16/2016	09/16/2017
Signal Generator	Rohde & Schwarz	SMBV100A	1407.6004K02	09/16/2016	09/16/2017
Power Sensors	Rohde & Schwarz	OSP120	1520.9010.02	09/16/2016	09/16/2017

* Calibration of equipment past due for re-calibration will be performed expeditiously. If any equipment is found to be out of tolerance at that time, affected customers will be notified accordingly.

7 EMC Test Plan

7.1 Introduction

This section provides a description of the Equipment Under Test (EUT), configurations, operating conditions, and performance acceptance criteria. It is an overview of information provided by the manufacturer so that the test laboratory may perform the requested testing.

7.2 Customer

Table 8: Customer Information

Company Name	JADAK
Address	7279 William Barry Blvd.
City, State, Zip	North Syracuse, New York, 13212 USA
Country	U.S.A.

Table 9: Technical Contact Information

Name	Steven Bryant
E-mail	sbryant@jadaktech.com
Phone	(315) 218-1342

7.3 Equipment Under Test (EUT)

Table 10: EUT Specifications

EUT Specifications	
Package Dimensions	6cm x 4cm x 0.5cm
Input Voltage	5.0 Vdc
Environment	Indoor
Operating Temperature Range:	-40 to 85 degrees C
Multiple Feeds:	☐ Yes and how many ☒ No
Product Marketing Name (PMN)	6XYZ-0003-01
Hardware Version Identification Number (HVIN)	6XYZ-0003-01
Firmware Version Identification Number (FVIN)	NOT SPECIFIED
Hardware Version	Rev. B2
Part Number	Module: 1803-0180-00 Antenna: 1000-0002-86 Rev A.
RF Software Version	NA
Bluetooth Radio	
Operating Mode	BDR
Transmitter Frequency Band	2402 MHz to 2480 MHz
Operating Bandwidth	1 MHz
Max. Power Output	2.97mW (4.73 dBm)
Power Setting @ Operating Channel	Fixed in Chipset.
Antenna Type	1 Swivel SMA antenna
Antenna Gain	4.4 dBi
Modulation Type	GFSK
Data Rate	1 Mbps
Note: This report only documents the radio characteristics for 2402 - 2480 MHz bands.	

Table 10a: Host Specifications

Host Specifications	
Model Name:	PR-655 SpectraScan Spectroradiometer
Type of Product:	Spectroradiometer which provides spectrally based photometric and colorimetric measurements, source spectral power distribution, dominant wavelength, and correlated color temperature.
Serial Number:	65164102
EUT Description:	The unique design of the PR-655 makes tasks such as spectrally based photometric and colorimetric measurements, source spectral power distribution, dominant wavelength and correlated color temperature quick and simple.For applications other than radiance or luminance the PR-655 can be supplied with optical accessories such as a cosine receptor for irradiance/illuminance. LR-127 LED Analyzer for testing LED's to CIE 127, fiber probe for remote non-line-of-sight luminance testing, and a series of magnification lenses for small spot size analysis. An RGB Display Caloption is available that provides an interactive method for white point calibration based on spectral measurements.
Product Environment:	Light Industrial.
EUT Modes of Operation:	The PR-655 is controlled by a touch-panel LCD and from some dedicated front-panel switches. Before taking measurements, the operator enters setup and mode information and then starts the measurement process. The results are displayed on the LCD screen. EUT performance is assessed by monitoring the LCD readings.
EUT Clock/Oscillator Frequencies:	The processor clock is 199.1 MHz.

Table 11: Interface Specifications

Interface Type	Cabled with what type of cable?	Is the cable shielded?	Maximum potential length of the cable?	Metallic (M), Coax (C), Fiber (F), or Not Applicable?
USB to Serial (3.3V TTL)	Flat Flex Cable	☒ No	☒ Metric: 30 cm	☒ M

Table 12: Supported Equipment

Equipment	Manufacturer	Model	Serial	Used for
Laptop	Lenovo	Type 4287	R9-KVE5H	Setup EUT operating channel
USB Adapter	FTDI	TTL-R232RG	N.A	Access Bluetooth radio chipset
Note: None.				

Table 13: Description of Sample used for Testing

Device	Serial	RF Connection	CFR47 Part 15.247
JADAK/PRI P/N 6XYZ-0003-01	W31300084	w/ SMA Antenna	TX Emissions, Rad. Bandedge.
		w/o SMA Antenna	Transmit Power, Occupied Bandwidth, Out of Band Emission, Hopping Requirement

Table 14: Description of Test Configuration used for Radiated Measurement.

Device	Antenna	Mode	Setup Photo (X-Axis)	Setup Photo (Y-Axis)	Setup Photo (Z-Axis)
JADAK/PRI P/N 6XYZ-0003-01	Integrated	Transmit	Laid Flat	EUT Sideway	EUT Upright.
Note: All emission scans performed on the Z-Axis with antenna upward; worst case.					

Table 15: Final Test Mode for 2402 MHz to 2480MHz Channels

Test	802.15.1
Occupied Bandwidth CFR 47 15.247(a1), RSS-Gen Sect.6.6, RSS 247 Sect. 5.1(a).	2402, 2441, 2480 MHz at BDR
Output Power CFR47 15.247 (a1), RSS 247 Sect. 5.4(b)	2402, 2441, 2480 MHz at BDR
Out of Band Emission CFR47 15.247 (d), RSS 247 Sect. 5.5	2402, 2441, 2480 MHz at BDR
Hopping Requirements CFR47 15.247 (a1), RSS 247 Sect. 5.1(d)	2402, 2441, 2480 MHz at BDR
Band-Edge (Radiated) FCC Part 15.205 & 15.209, RSS -Gen Sect.8.9	2402, 2480 MHz at BDR
Transmitted Spurious Emission (30 MHz – 1GHz) FCC Part 15.205 & 15.209, RSS -Gen Sect.8.9	2441 MHz at DH5. (EUT has no critical magnetic component for generating magnetic field)
Transmitted Spurious Emission (Above 1GHz) FCC Part 15.205 & 15.209, RSS -Gen Sect.8.9	2402, 2441, 2480 MHz at DH5
AC Conducted Emission FCC Part 15.207, RSS-Gen Sect.8.8	EUT is powered by a 5.0 VDC via host device.
Note: 1. Pretest showed DH5 was the worst case.. 2. All radiated emission performed on Z-Axis. 3. All tests were pre-scanned to determine worst case before final testing.	

7.4 Test Specifications

Testing requirements

Table 16: Test Specifications

Emissions and Immunity	
Standard	Requirement
CFR 47 Part 15.247: 2017	All
RSS-247 Issue 2, 2017	All

END OF REPORT